



# **ANNUAL REPORT**

**July 1, 2010 – June 30, 2011**

**Submitted by:**

**The Center for Water and Society Advisory Committee**

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## 2 CWS Mission Statement

*Statement of Purpose.* The purpose of the Michigan Technological University Center for Water and Society (CWS) is to enhance the ability and the visibility of MTU personnel to solve water-related problems of local, regional, and international interest.

*Mission Statement.* The mission of the CWS is to promote research, education, and outreach in all disciplines at Michigan Tech related to water issues. The objectives of the CWS are

- to serve as a focal point for instructional and research activities in water-related fields and water-related outreach activities across the Michigan Tech campus;
- to provide an organizational structure that supports continuing growth in water-related fields and outreach activities and encourages interdisciplinary projects;
- to support interdisciplinary graduate and undergraduate education and research in water related fields;
- to pursue external funding opportunities to support these objectives and to facilitate CWS participating faculty to obtain external support; and
- to enhance the visibility of MTU and CWS as centers of expertise and cutting-edge research in water-related fields.

CWS has 55 faculty/staff participants and 90 graduate student and 28 undergraduate student participants in 12 units across the Michigan Tech campus (see Appendices 1 and 2). CWS is governed by a director and advisory committee (see Appendix 3).

The newly approved renewal proposal which includes a five year plan can be viewed at: [http://www.mtcws.mtu.edu/pdf/CWS\\_Renewal\\_through\\_Dec2015.pdf](http://www.mtcws.mtu.edu/pdf/CWS_Renewal_through_Dec2015.pdf)

### **3 CWS Year in Review**

#### **3.1 Seminars & Symposia Subcommittee Activities**

(Members: Daya Muralidharan, Carol MacLennan, Joan Chadde, Alex Mayer)

The primary activity of the Seminars & Symposia Subcommittee was the planning and organization of CWS seminars. The largest CWS event takes place on World Water Day, March 22 of each year. The World Water Day events include a student poster competition, a guest lecturer, and a CWS social. The following events were sponsored or co-sponsored in 2010-11 by CWS.

##### **3.1.1 World Water Day Poster Competition – March 22, 2011**

CWS celebrated World Water Day 2011 by hosting a social to view the World Water Day Student Poster entries, and to meet the World Water speaker, Nancy Langston from the University of Wisconsin-Madison.

The Student posters were judged during the day, and were set up on display during the social. The World Water Day Poster competition included Original Research and Coursework/Informational award categories. The posters are presented in PDF format on the CWS web page at:

[http://www.mtcws.mtu.edu/2010CWS\\_Posters.html](http://www.mtcws.mtu.edu/2010CWS_Posters.html)

The awards for the Poster competitions are as follows.

##### **Original Research Posters**

###### **1<sup>st</sup> Place Award (\$250)**

Danielle Haak

*“Impact of Copper Mine Tailings on Survival and Early Development of Lake Sturgeon and Lake Trout near Gay, Michigan”*

###### **2<sup>nd</sup> Place Award (\$150)**

Jonathan Ebel

*“Biofilm Response to Nutrient Mitigation Using Salmon Carcass Analog in Central Idaho Streams“*

###### **3<sup>rd</sup> Place Award (\$100)**

Laura Kangas

*“Artificial microtopography facilitates northern white cedar (Thuja occidentalis L.) survival in created wetlands”*

## **Coursework/Informational Posters**

### **1<sup>st</sup> Place Award (\$250)**

Aleta Daniels

*“A non-biased look at drilling for natural gas”*

### **2<sup>nd</sup> Place Award (\$150)**

Ellis Adams

*“The Ramsar Convention on Wetlands: Is it Effective in Sub-Saharan Africa?”*

### **3<sup>rd</sup> Place Award (3-way tie for \$100 each)**

Mariah Maggio

*“The Policy Path to Human Rights Status: Water and Sanitation”*

Jon Bontrager

*“Natural Resource Damage Assessments and Damages Owed Following Large Oil Spills in Marine Environments”*

Jessica Billings

*“The Value of Dam Removal on the Elwha River”*

## **3.1.2 CWS Seminars and Lectures**

### **World Water Day Lecture, March 22, 2011**

Dr. Nancy Langston, Environmental Historian

University of Wisconsin-Madison

Evening Lecture *“Sustaining Lake Superior”*

Afternoon Seminar: *“Toxic Bodies”*

### **Green Film Series, April 21, 2012**

*“Homeland: Four Portraits of Native Action”*

Discussion facilitator: Chuck Brumleve, Environmental Mining Specialist, Keweenaw Bay Indian Community

## **3.2 Degree and Education Subcommittee Activities**

**(Members:** John Gierke, Tom Pypker, Alex Mayer)

The primary activities of the Degree Subcommittee included the development of the CWS graduate level colloquium course, the development of the CWS Graduate Certificate in Sustainable Water Resources Systems, and the review of the Graduate Student Research and Travel grants awarded by CWS.

### 3.2.1 Colloquium Course

A new colloquium course was established in Spring 2009. The purpose of the colloquium is to review and discuss current interdisciplinary advances in a water topic of interest to CWS participants. The one-credit course is temporarily listed under UN5100 – Center for Water & Society.

Each week, participants read a journal paper or scientific report in preparation of discussion sessions on Fridays. Students not registered for the course and faculty are encouraged to participate. Discussion sessions are led by a group of students and faculty. This group prepares questions or comments the week preceding the discussion and sends these to the class. The group begins the discussion session with a 10-minute summary of the major issues covered the preceding week's reading and repeat the discussion questions. After the "formal" one-hour discussion session, course participants are invited to stay and continue the discussion. Students are expected to (a) produce and present a poster on a relevant topic for the Center for Water & Society's World Water Day poster session and (b) write and submit a 5-page reflection paper due at the end of the term.

#### *Colloquium Topics:*

**Spring 2011:** *"The Value of Water"*

**Spring 2010:** *"Impacts of Climate Change on the Great Lakes Ecosystem"*

**Spring 2009:** *"Climate Change and the Sustainability of Water Resources"*

### 3.2.2 Graduate Certificate in Sustainable Water Resources Systems

In Spring 2009, a proposal to establish a Graduate Certificate in Sustainable Water Resources Systems was submitted for approval by the Provost and Vice President for Academic Affairs. This Certificate formally recognizes students will have a set of core competencies in understanding current water resource issues and develop an advanced understanding of the problems and new technology development in their field of expertise. This certificate will be useful to students in such fields as natural resource management, business and policy, environmental and civil engineering, geology and geological engineering, and environmental policy. Students who complete this certificate will be able to demonstrate that they understand water resource management from an interdisciplinary perspective that includes policy, natural sciences, and applied sciences. The certificate was approved November 6, 2009 and was offered to students in Fall 2009. <http://www.mtu.edu/gradschool/administration/academics/forms-deadlines/pdfs/Certificates-ICSW.pdf> .

This year the requirements of the graduate certificate were modified. The minimum number of credits required is now 12 instead of 15, and additional courses were added to the 4 topic areas.

### **3.2.3 Graduate travel awards**

**Rabi Gyawali, June 27-July 1, 2010 (\$400.00)**

Joint Federal Interagency Conference 2010

Las Vegas, Nevada

*“Surface water hydrologic modeling of Kalamazoo River watershed”*

**Agustin Robles, December 13-17, 2010 (\$300.00)**

American Geophysical Union (AGU) Fall 2010 Meeting

San Francisco, California

*“Spatial Streamflow Forecasting in a Large River Basin in Northwestern Mexico using a Fully-distributed Hydrologic Model”*

**Rungroj Benjakul, December 13-17, 2010 (\$300.00)**

American Geophysical Union (AGU) Fall 2010 Meeting

San Francisco, California

*“Modeling Dioxane Transport in a Heterogeneous Glacial Aquifer System (Washtenaw County, Michigan) Using Publicly Available Models and Data”*

**Casey Fritsch, May 22-26, 2011 (\$300.00)**

2011 World Environmental & Water Resources Congress

Palm Springs, California

*“Evaluation of Flood Risk Under Climate Variability Using Continuous Hydrologic Modeling”*

**Matt Van Grinsven, December 13-17, 2010 (\$300.00)**

American Geophysical Union (AGU) Fall 2010 Meeting

San Francisco, California

*“Estimation of Vertical Groundwater Fluxes into a Streambed through Continuous Temperature Profile Monitoring and the Relationship of Groundwater Fluxes to Coaster Brook Trout Spawning Location”*

**Andrew Kozich, June 4-8, 2011 (\$300.00)**

International Symposium on Society and Natural Resources

Madison, Wisconsin

*“Relationships between values, beliefs, and water-impacting behaviors in the Great Lakes watershed”*

**Ellis Adams, June 4-8, 2011 (\$300.00)**

International Symposium on Society and Natural Resources

Madison, Wisconsin

*“Privatization of Water Services: Implications on the Activities of Water Sector NGOs”*

### 3.2.4 Graduate research grants

**Danielle Haak (\$500.00)**

*“The impact of migrating copper mining stamp sands on fish spawning reef habitat in Lake Superior and on use of ephemeral ponds lined with stamp sand on frog spawning”*

**Nathan Arnold (\$500.00)**

*“The hydraulic conductivity and silver leaching observed in the Potters for Peace (PFP) and FilterPure water filters over time”*

### 3.3 Ad hoc charter revision subcommittee:

(Members: Tom Pypker, Alex Mayer)

The Center for Water and Society submitted a revised charter along with a proposal to renew the center for another 5 years. On April 27, 2011, the Vice President for Research approved the renewal through December 31, 2015. The Center for Water and Society became an independent research center at Michigan Tech, and is no longer under the direction of the Sustainable Futures Institute. The new Institutional Research and Development (IRAD) structure is as follows:

CWS	20%
PI	10%
Department (or Unit)	10%
College	10%

The approved renewal proposal which includes a five year plan can be viewed at:

[http://www.mtcws.mtu.edu/pdf/CWS\\_Renewal\\_through\\_Dec2015.pdf](http://www.mtcws.mtu.edu/pdf/CWS_Renewal_through_Dec2015.pdf)

### 3.4 Ad hoc new director subcommittee

(Members: Casey Huckins, Brian Barkdoll, Alex Mayer)

The center was structured so that the position of the director would be rotated among the Advisory Committee members or other active CWS members. Alex Mayer served as director for over 5 years, as the first CWS director. The Ad hoc new director subcommittee was formed to find a new director. Noel Urban begins as the CWS director in September 2011.

### 3.5 Awards and Recognition for CWS Participants

**Auer, Nancy A.**

Included in "Lake Superior Profiles: People on the Big Lake", John Gagnon, May 24, 2010.

**Becker, Jennifer G.**

Distinguished Service Award, Association of Environmental Engineering and Science Professors, October 4, 2010.

**Beckwith, Mary Ann**

Who's Who in American Art, 2010.

**Chadde, Joan S**

Co-recipient of Copper Country Education Leadership Award, together with Ms. Shawn Oppliger, director, Western U.P. Center for Science, Mathematics & Environmental Education, 2010.

Inducted into the Michigan Tech Academy of Educators, 2010.

Michigan Nature Association 2010 Volunteer of the Year for coordinating the writing and publication of *Walking Paths in the Keweenaw: A Guide to 22 Nature Sanctuaries & Preserves*, 2010.

Project Learning Tree Michigan Educator of the Year, 2011.

**Flaspohler, David J.**

Board of Directors, Whitefish Point Bird Observatory, August 2010.

Outstanding Faculty Member of the Year, May 2010.

**Gorman, Hugh**

Fulbright Scholar, 2010

**Mayer, Alex S.**

Manierre Award, Huron Mountain Wildlife Foundation, 2010.

**Orr, Blair D.**

Faculty Distinguished Teaching Award, Michigan Tech, 2010.

**Perlanger, Judith**

Fulbright Scholar, 2010

***3.6 Participation of CWS Director and Advisory Committee in Initiatives, Conferences and Workshops in support of CWS***

The CWS director, advisory committee members and participants participated in the following Michigan Tech initiatives or efforts as representatives of CWS.

- June 2010-May 2011: CWS director continued as liaison between Michigan Tech and IBM
- June 2010-May 2011: CWS director continued as member of advisory board for Lake Superior Stewardship Initiative
- September 2010: CWS director attended "*Climate Change Adaptation in the Great Lakes: Advancing the Regional Discussion*," Buffalo, New York, sponsored by the National Wildlife Federation, Council of Great Lakes Industries, and Great Lakes Commission
- November 2010-January 2011: CWS director participated in discussions on partnership with Noble Odyssey Foundation and establishment of Scientific Diving and Boating program at MTU

- January 2011: CWS director attended “*Restoring Michigan’s Great Lakes: Opportunities in Year Two of the Great Lakes Restoration Initiative*,” Lansing, Michigan sponsored by the Statewide Public Advisory Council for Michigan’s Great Lakes Areas of Concern Program

### **3.7 Other activities**

- July 2010: CWS advisory committee agreed to support Agassiz up to \$3,000/year for five years. The \$3,000/yr will be required only if funds from other support areas (grants, contracts, course fees, etc.) are insufficient to cover *Agassiz* operation and maintenance expenses.
- January 2011-June 2011: CWS advisory committee agreed to co-sponsorship of Green Film Series
- February 2011-July 2011: CWS submitted REF Infrastructure Enhancement proposal (developed by Noel Urban); grant was awarded; CWS agreed to provide \$5,000 cost share in support of Michigan Tech’s sediment collection capabilities. These improvements will expand the capabilities for sediment core and trap collection both on the *Agassiz* and from other research vessels.

## 4 CWS Budget

### **CWS Institute O/H Inventive Account**

Beginning Balance July 1, 2010 .....	<b>\$4,247.40</b>
Research Incentive Transfer In .....	<b>\$34,474.90</b>
Expenditures .....	<b>\$16,395.57</b>
CWS Sponsored Lectures.....	\$508.45
Student Research & Travel Grants .....	\$3,200.00
Student Research Poster & Art Competition Awards .....	\$1,200.00
Center Supplies.....	\$0
Administrative Assistant .....	\$ 9,316.29
Travel .....	\$1,169.39
Center Functions.....	\$1,001.44
Balance as of June 30, 2011 .....	<b>\$22,326.73</b>

## 5 Research

### 5.1 New Awards 2010-11

#### New Research Funding 2010-11:

**\$ 1,607,640**

1. Evaluating Riparian Timber Harvesting Guidelines: Phase 3, Result 2 Evaluate Aquatic Habitat Impacts  
PI: Casey Huckins  
USDA Forest Service  
070542P3: \$10,432 (5/24/2007-6/30/2011, incremental funding)
2. Erosion Reduction by Air Entrainment, Phase IV  
PI: Barkdoll, Brian  
South Florida Water Management District  
080217P5: \$27,999 (10/1/2010 - 9/30/2011)
3. SustR: Sustainable Development for Rural Communities: Social, Health, Economic, and Environmental Advances  
PI: Mayer, Alex  
co-PI: MacLennan, Carol  
co-PI: Orr, Blair  
US Dept of Education  
080423P3: 50,000 (9/1/2010 - 8/31/2011, incremental funding)
4. IDR: Collaborative Research: Sustainable Water Resources for Communities Under Climate Change: Can State-of-the-Art Forecasting Inform Decision-Making in Data Sparse Regions?  
PI: Mayer, Alex (CEE)  
co-PIs: Halvorsen, Kathleen (SS/SFRES)  
National Science Foundation  
091213P2: \$317,389 (9/15/2010-8/31/2013)
5. Predicting Ecosystem Changes in Lake Superior  
PI: Auer, Nancy  
co-PI: Auer, Martin  
US Environmental Protection Agency  
100181P1: \$306,014 (9/1/2010 - 4/30/2013)
6. WSC-Category 1: Humans, Hydrology, Climate Change, and Ecosystems-An Integrated Analysis of Water Resources and Ecosystem Services in the Great Lakes Basin  
PI: Mayer, Alex  
co-PIs: Breffle, William; Halvorsen, Kathleen; Pypker, Thomas; Urban, Noel  
National Science Foundation  
100422P1: \$150,000 (9/1/2010 - 8/31/2012)
7. Analysis of Hydrogeochemistry of Upland-Peatland Waterlands Using Isotopic Tracers  
PI: Mayer, Alex  
US Dept of Agriculture  
100506P2: \$1,500 (5/20/2010 - 4/30/2011)
8. Great Lakes Maritime Education for K-12 Teachers  
PI: Chadde, Joan  
University of Wisconsin - Superior  
100611P2: \$15,000 (10/1/2010 - 9/30/2011)

9. Virtual Water Accounting: A New Paradigm for the Adaptive Management of Great Lakes Water  
 PI: Mayer, Alex (CEE)  
 Co-PI: Huckins, Casey (BIO)  
 Great Lakes Protection Fund  
 100679P2: \$916,736, Awarded
  
10. Evaluation of Suitability from Native Species Restoration in the 1836 Treaty Area with Prescriptions  
 Developed for Arctic Grayling  
 PI: Auer, Nancy (BIO)  
 co-PI: Huckins, Casey (BIO)  
 Little River Band of Ottawa Indians  
 1010065P1: \$149,999, Awarded
  
11. Acoustic Measurement of Pipe Discharge Downstream of 90-degree Bend  
 PI: Barkdoll, Brian (CEE)  
 South Florida Water Management District  
 1103051P1: \$49,203, Awarded
  
12. Evaluation of Larval Lake Sturgeon Production on Fighting Island Reef in the Detroit River  
 PI: Auer, Nancy  
 US Dept of the Interior  
 100684P1: \$ 60,611 (2/18/2011 - 9/30/2012)
  
13. Great Lakes Maritime Education for K-12 Teachers  
 PI: Chadde, Joan  
 University of Wisconsin - Madison  
 1012026P1: \$15,000 (10/1/2010 - 9/30/2011)
  
14. A Linked Sediment-Water Column Model for Onondaga Lake  
 PI: Auer, Martin  
 Upstate Freshwater Institute Inc  
 100612P1 : \$54,494 (1/1/2010-5/31/2011)
  
15. Upgrade to MTU Sediment Collection Capabilities  
 PI: Alex Mayer  
 REF-IE program  
 1106069P1: \$20,000

## 5.2 Active Research Projects Affiliated with CWS, 2010-11

**Total Research Expenditures 2010-11: \$1,496,917**

**1. Collaborative Research: The carbon balance of Lake Superior: modeling lake processes and understanding impacts on the regional carbon budget**

PI: Noel Urban  
Sponsor: NSF

The purpose of the North American Carbon Program (NACP) is to (1) to develop quantitative scientific knowledge, robust observations, and models to determine emissions and uptake of CO<sub>2</sub>, CH<sub>4</sub>, and CO<sub>1</sub> changes in carbon stocks, and factors regulating these processes for North America and adjacent ocean basins; and (2) to develop the scientific basis for full carbon accounting on regional and continental scales. The Laurentian Great Lakes cover 25% of the land area of the 8 Great Lakes states, and CO<sub>2</sub> emission and seasonal cycling from them may be comparable to local terrestrial ecosystems. Although their contributions to the regional carbon balance may be significant, these fluxes are currently poorly understood. CO<sub>2</sub> fluxes from Lake Superior are of particular interest because they may directly impact observations at nearby AmeriFlux towers.

Motivated by the need for improved knowledge of Great Lake CO<sub>2</sub> fluxes, we will couple an exosystem-carbon module to an existing hydrodynamic model of Lake Superior to estimate these fluxes and their spatial and temporal variability. We will also obtain new wintertime observations of carbon parameters in the lake to constrain this model. Using model output, we will evaluate the impact of Lake Superior CO<sub>2</sub> fluxes on observations at AmeriFlux towers and on the regional carbon budget.

Sampling of water intakes has clearly shown the annual cycle in pCO<sub>2</sub>, chlorophyll, and other analytes. Comparison of municipal water intakes with ship-based sampling has revealed that while comparable results were obtained at one intake location, a second location has yielded large differences. All biological parameters (bacterial counts, bacterial growth rates, carbon fixation rates) are markedly lower in the samples from the Ontonagon municipal water intake than in samples collected from a boat at the same location.

Measurements of CO<sub>2</sub> concentrations in air above the lake have been collected with an open-path IRGA mounted on the ferry to Isle Royale over the 100-km route across the open lake from the Keweenaw Peninsula to Isle Royale. While concentrations above the lake are higher than above land at the corresponding time, we do not yet know if this is just the result of the time lag as an air mass is advected across the lake. We anticipate being able to make eddy covariance measurements of CO<sub>2</sub> fluxes on at least three occasions this year.

Development of the lower-food web model is being conducted by Cory McDonald, the doctoral student on the program. Cory is using information theory to derive an optimized food web model with a minimum number of components. This modeling shows that while model fit to experimental data generally improves with increasing number of calibration or fitting parameters, the Akaike Index reaches a minimum in models with an intermediate number of fitting parameters. The ratio of number of measurements to number of fitting parameters determines the optimal complexity of the model. Results from this work have been presented at four international conferences, and the first manuscript will be submitted in August 2008 to Ecological Modeling.

**2. Evaluating Riparian Timber Harvesting Guidelines: Phase 3, Result 2 Evaluate Aquatic Habitat Impacts**

PI: Casey Huckins  
Sponsor: USDA Forest Service, Northern Research Station

Our primary objective is to assess long-term effects of riparian harvest techniques on stream ecosystem function at the LCMR sites and Pokegema Creek sites. The following objectives are included into the study plan:

- Quantify available food resources for stream food webs (periphyton and detrital standing crops), and macroinvertebrate response (biomass of functional feeding groups and diets) in stream reaches subjected to various riparian harvest treatments.
- Evaluate breakdown rates of leaf litter and wood in streams under the different riparian treatments.

Results from this research will be used to validate or revise the State of Minnesota's riparian forest management guidelines and demonstrate the use of functional measures of ecological integrity for assessment of stream health.

3. **Collaborative Research: Modeling and Analyzing the Use, Efficiency, Value and Governance of Water as a Material in the Great Lakes Region Through an Integrated Approach**

PI: Alex Mayer

co-PIs: James Mihelcic, David Watkins, Qiong (Jane) Zhang

Sponsor: NSF

This multidisciplinary 5-year research project (funded by the National Science Foundation MUSES program) will determine, through integrated physical and economic models and under various scenarios of population growth, climate change, land use, and emissions, the impact of direct and indirect drivers on water quality, quantity, and availability in the Great Lakes region.

Though it is well known that nearly every product in global commerce is dependent on water, water has not traditionally been considered a material characterized by integrated analyses to quantify flows and stocks, opportunity costs, and full valuation (i.e., social, environmental, and service costs) through its myriad of uses. This has led to an undervaluing of water as a finite resource.

The Great Lakes region is chosen due to its large volume of available freshwater (but low rate of replacement), high economic impact, complex governance issues including an international border, and increasing competition for water allocation among industrial, agricultural, municipal, recreational, and ecosystem needs, as well as existing and future threats of water quality deterioration.

4. **Characterizing Lessons Learned from Federal Biomass Removal Projects**

PI: Kathy Halvorsen

Sponsor: U.S. Forest Service

Since the inception of the National Fire Plan in 2001, fuels reduction treatments have increased from about 2.1 million acres to more than 3.0 million acres annually in 2006 (Healthy Forests and Rangelands 2007). Biomass utilization is seen as a growing component to treating greater numbers of acres at high risk of wildfire, particularly within an ever-expanding wildland-urban interface. There are however challenges to biomass removal that impede progress. Understanding those challenges and how land managers and community partners have worked together to overcome them is a necessary part of reducing the threat of wildfire.

We focus on understanding the challenges faced by and innovations created to overcome them that managers and communities around the U.S. have encountered as they try to reduce fire risk. To do this we have done 12 case studies of federal and tribal land management chosen based on a set of key characteristics. These case studies range from the Green Mountain National Forest in Vermont, to the South Carolina Francis Marion, to the Southwestern Four Corners area, to the Shasta-Trinity National Forest in Northern California, and to the Superior National Forest in Northern Minnesota. We have completed our case studies conducting about 150 open-ended interviews with managers, NGO staff, community members, and industry employees. Transcriptions of the interviews will be analyzed for patterns, and case studies will be prepared on our findings for distribution to the fire management community and publication in peer reviewed publications.

5. **Graduate student scholarships to advance a global outlook of economic and social prosperity that protects the environment**

PI: Judith Perlinger

co-PIs: Veronica Griffis, James Mihelcic, Kurt Paterson, Qiong Zhang

Sponsor: NSF

Judith Perlinger, Veronica Griffis, James Mihelcic, Kurt Paterson, Jane Zhang of the Civil and Environmental Engineering's Michigan Tech Center for Water and Society have received an award in the amount of \$599,978 from the National Science Foundation for a project titled Graduate Student Scholarships to Advance a Global Outlook of Economic and Social Prosperity that Protects the Environment. The project provides up to eighteen need-based scholarships annually to an integrated community of MS and PhD graduate students who are not only educated in the economic, social, and environmental pillars of sustainability but will also transfer research techniques and knowledge from their different graduate perspectives. This program partners with the U.S. Peace Corps incorporating 2+ years of overseas engineering service.

6. **SustR: Sustainable Development for Rural Communities: Social, Health, Economic, and Environmental Advances**

Investigator: Alex Mayer (GMES), Carol MacLennan (SS), and Blair Orr (SFRES)

Sponsor: U.S. Dept of Education, Fund for the Improvement of Post-Secondary Education

A consortium of six research-based universities and colleges in Mexico, Canada and U.S. has been formed to tackle the most critical issues in rural sustainability by educating a new generation of students and creating collaborative ties among researchers at these institutions. The consortium universities will exchange students and faculty in several engineering and science disciplines (anthropology, sociology, political science, biology, health sciences, environmental engineering and sciences, forestry) involved in finding social, political, economic and technical solutions to the problems of rural communities.

These universities offer a broad range of expertise in the area of rural sustainability, from social sciences, including an understanding of the social dynamics and economics in rural communities; public and community health, including an understanding of determinants of community and individuals' health in rural and remote communities; natural sciences, including an understanding of the capacity of the natural environment to sustain development in rural communities; and engineering, including knowledge of how to design, build and manage technical solutions.

Faculty activities will focus on the development of a general web-based course in water resources and intensive courses in urban water issues, and on the compilation of a collection of web-based case studies in water resources systems in North America. Faculty at the institutions will benefit immensely from exchange and discussion with each other as they compare the differences and similarities in their home territories. This exchange will enable students to learn in an "integrated" manner that not only combines diverse disciplines, but also the histories and experiences of the different regions. In effect this will be a laboratory for student learning and preparation for resolving a central problem that faces rural communities: linking reduction in poverty and increasing sustainability.

7. **Erosion Reduction by Air Entrainment, Phase 2**

PI: Brian Barkdoll

Sponsor: S. Florida Water Management District

Excessive scour of sediment can be a problem at hydraulic structures if the scour depth is such that it undermines the structure's foundation, which can lead to sliding, tilting, and potentially to the collapse of the structure. Scour is induced by flowing water in the various modes of sediment rolling, saltation, or entrainment into the flow as suspended load. Moreover, drought conditions followed by a large storm may result in excessive scour due to the low-flow depth protecting the sediment from scour downstream of hydraulic structures. Under such conditions the flow sediment carrying capacity can be exacerbated by the type and length of the hydraulic jump at the terminal structure, which will, in turn, scour large holes in the channel bed downstream of the terminal structure.

The SFWMD has numerous gated control structures in which there is not only flowing water but plunging water as well. The primary objective of Phase 2 of this project is identify the relationship between hydraulic flow and downstream erosion scour, with the goal of reducing scour at actual District structures. The investigation is to be performed on a reduced-scale model flume of a District gate that has been previously constructed in order to evaluate opportunities to reduce the formation of down-stream scour holes. The use of an air-curtain to disrupt the hydraulic flow has been shown to mitigate the effect of scour erosion. This effort is intended to learn more about the effect of placement of the air curtain, the effect of the air flow volume on scour, and the impact on conveyance capacity when an air curtain is activated. Based on the insight gained from these laboratory investigations, an investigation intended to identify a suitable field structure for performing future investigations will be performed. Actual field testing is not covered under this SOW.

8. **Component 3, Compile and Analyze Regional Data Sets: Work Plan FY2009, Water Quality Management Program, United States EPA Clean Water Act sect. 106**

PI: Casey Huckins (SFRES)

Sponsor: Little River Band of Ottawa Indians

The LRBOI water quality program has a substantial amount of data on Reservation waters. The Trial data sets provide a good snapshot of water quality in a particular water body. However, to fully characterize water quality it will be valuable to compare data on Reservation waters with similar water bodies in the Great lakes eco-region.

Ideally a scale of gradient of water quality can be developed, ranging from the highest quality waters in the eco-region to the most impaired. Subsequently, data on Reservation waters can be evaluated relative to this gradient. This will help answer questions such as, how does the quality of Reservation waters compare to other waters in the eco-region? Are there signs of opportunities for water quality improvement?

To accommodate valid, regional comparisons, the LRBOI proposes a 2-phased process. In Phase 1 the Tribe will compile and review available data from multiple sources on water bodies in the Great Lakes eco-region. The data will be reviewed to determine the feasibility of building a complete data set that covers more of the ecological condition gradient. Assuming the Phase 1 succeeds indicates it would be feasible and beneficial to proceed, in Phase 2 the LRBOI will build a condition gradient, using appropriate IBI's/metrics, and will begin to evaluate data on Reservation water resources against this gradient.

The overall objective for the Phase 1 workplan element is to develop a gradient, using a valid index/metric(s) and reflective of regional water quality data that can be used for evaluating data on Reservation water resources.

The key components of this phase are:

1. Compile and analyze (QA/QC) data sets from area watersheds.
2. Compile possible metrics/IBIs that current data may be utilized in.

## **9. Enhancing the Capacity for Sustainable Forest Management in Chiapas and Oaxaca**

PI: Alex Mayer (GMES)

co-PI: Kathleen Halvorsen (SFRES/SS)

Sponsor: Higher Education in Development/USAID

The forests of Chiapas and Oaxaca provide an excellent opportunity for the pursuit of integrated sustainability-related projects that protect local communities, economies, and ecosystems. Oaxaca and Chiapas are two of the most ecologically and culturally diverse states in Mexico. However, these states simultaneously confront problems of high levels of poverty, poor education and public services, and rapid rates of environmental destruction. The formation of human resources having the broad range of skills and experience needed to address these problems is crucial to promoting the wise use of the state's natural resources to meet the productive needs of human populations while ensuring the maintenance of the unique flora, fauna, and ecological processes supported by the diverse ecosystems in the region.

We suggest that there is a need for forest managers in Chiapas and Oaxaca who are prepared to apply the concepts of integrated sustainability to resolve the critical forest resources issues facing these states. Thus, the goal of our project is to train a new generation of interdisciplinary experts in managing forest for the sustainable provision of diverse ecosystem services, and in applying emerging policy and financial instruments such for achieving greater balance between forest conservation with local economic development in Chiapas and Oaxaca. This project will be a partnership between Michigan Technological University (MTU) and the Colegio de la Frontera Sur (ECOSUR) in Chiapas and the Instituto Tecnológico del Valle de Oaxaca (ITVO).

The proposed training will be conducted via curricula tailored to fit within existing Master's degree programs at MTU. We will offer a unique combination of biophysical and social sciences, so that graduates will have a broad array of skills, from key disciplinary knowledge for sustainable forest management to integrative thinking and multi-disciplinary, collaborative problem-solving skills. The training will include coursework and field experiences in the U.S. and Mexico, through partnerships with government agencies and non-governmental organizations (NGOs) in the two countries. In addition, we will develop Diplomado programs in sustainable forest management at the Mexican partner institutions.

## **10. New GK12 Global Watershed: Integrating Rural and Global Perspectives with Research and Technological Advances**

PI: Alex Mayer (GMES)

Co-PIs: Nancy Auer (BIO), Linda Nagel (SFRES)

Sponsor: NSF

*Project Description/Intellectual Merit.* In project **GlobalWatershed**, graduate Fellows will conduct research in watershed science topics, at a range of scales and cultural contexts, while working with middle/high school teachers to create lesson plans that transfer this knowledge to their students. The goals of **GlobalWatershed** are to (a) expand traditional STEM graduate student training to allow graduate students to acquire improved teaching and communication skills and to gain a greater appreciation of the scientific context of their research, and make this expanded training a permanent fixture at MTU and to enrich STEM learning and instruction in local K12 schools serving low-income and high Native American populations and a Sonora, Mexico K12 school system, specifically by translating state-of-the-art watershed research to the K12 level, and make this enrichment

sustainable at these schools. Fellows will receive training in effective teaching techniques, learning styles, lesson planning, classroom management, ways of assessing science proficiency, inquiry-based approaches for teaching science, teaching concepts of scientific research, and indigenous perspectives and awareness and sensitivity to other ways of learning. Teachers will attend professional development workshops to learn about watershed science research and methodologies. Lesson plans and units will be developed by Fellows and teachers on a range of watershed topics, to be incorporated into secondary school curricula, including science, mathematics, and social studies. These materials will be aligned with appropriate Michigan and Sonora educational standards.

*Broader Impacts.* **GlobalWatershed** will integrate and strengthen global perspectives and technological advances in University research and rural secondary education. Fellows will gain research experience while also learning effective educational techniques and pedagogies from secondary school teachers. Together, the Fellow/teacher teams will impart knowledge of the many components of watersheds to secondary students. Teachers will become proficient in the use of new technologies in their classrooms, increase their research experience, and learn to address watershed research questions into their lessons. Our focus on Native American students will help us develop appropriate educational materials for a group that is traditionally under-represented in science and engineering. The collaboration with schools in Sonora will allow for exchanges in teaching strategies and will enrich the outlooks of all participants by exposure to a region where water scarcity is a day-to-day reality. Dissemination will occur via the **GlobalWatershed** web site and presentations at professional conferences and publications in peer-reviewed journals.

#### 11. **Scour Reduction Through Air Injection, Phase III**

PI: Barkdoll, Brian (CEE)  
South Florida Water Management District  
\$49,991 (incremental funding, 080217P3)

The South Florida Water Management District manages and operates various water control structures that are subject to scour erosion damage. In an effort to reduce scour downstream of these gated structures, laboratory experiments have been performed to investigate the effect of a bubble curtain introduced downstream of the terminal structure of a gated spillway on the depth of the scour hole. The experiments were performed in an approximately 3D-foot-long, 3-ft wide, and 4-ft high hydraulic channel. Early experiments consisted of a limited number of proof-of-concept tests to investigate if the introduction of air reduces scour at all through the use of an air diffuser pipe with holes at specified diameter and spacing, angle, and lateral extent. Subsequent experiments verified the worst scour flow conditions, found the optimal location and air flow rate, and investigated whether or not air injection altered the conveyance. This project will consist of additional experiments over a broad range of values of diffuser hole size and spacing, the angle of air entrainment, and the width of air diffuser.

Excessive scour of sediment can be a problem at hydraulic structures if the scour depth is such that it undermines the structure's foundation, which can lead to sliding, tilting, and potentially to the collapse of the structure. Scour is induced by flowing water in the various modes such as rolling, saltation, or entrainment into the flow as suspended load. The SFWMD has numerous gated control structures in which there is not only flowing water but plunging water as well. Alteration of the gated structure is cost prohibitive. The implementation of structural changes for control of the hydraulic jump and installation of riprap can also be expensive. Use of the air-bubble curtain downstream of the terminal structure may be an inexpensive method of scour reduction.

The objective of this project will be to identify the relationship between hydraulic flow and downstream erosion scour, with the goal of reducing scour at actual District structures. The investigation is to be performed on a reduced-scale model flume of a District gate that has been previously constructed in order to evaluate opportunities to reduce the formation of down-stream scour holes. The use of an air-curtain to disrupt the hydraulic flow has been shown to mitigate the effect of scour erosion. This effort is intended to learn more about the effect of the diffuser hole size and spacing, the angle of air entrainment, and the width of air diffuser on scour depth. Based on the insight gained from these laboratory investigations, an investigation intended to identify a suitable field structure for performing future investigations will be performed. Actual field testing is not covered under this SOW.

#### 12. **Great Lakes Maritime Education for K-12 Teachers**

PI: Chadde, Joan (CEE)  
University of Wisconsin - Superior  
\$34,999 (incremental funding, 090621P2)

The Center for Science, Mathematics & Environmental Education at Michigan Technological University (MTU) requests support from GLMRI to continue & expand several of the successful Great Lakes Maritime Transportation education/outreach programs that have been implemented 2006-2008. Specifically, the Center

proposes to conduct two summer teacher institutes--- a new institute on Mathematics & Navigation to be held at MTU, and a new Great Lakes Maritime Transportation institute to be conducted at (and in partnership with) the Toledo Maritime Academy and University of Wisconsin in Madison. In addition, the Center proposes to conduct two teacher workshops during the school year. Possible locations are: Great Lakes Shipwreck Museum at Whitefish Point in Paradise, MI, the Michigan State Historical Museum in Lansing, Sturgeon Bay in Door County, or the Maritime Museum in Manitowoc, WI. The workshops will result in the development and publication of a lesson & activity guide on Great Lakes maritime transportation. Eight more Great Lakes maritime transportation education chests will be assembled and distributed to education/outreach institutions in the Great Lakes region (28 have been disseminated in the past 3 years).

### 13. **Monitoring Zebra Mussel Phosphorus Excretion**

PI: Marty Auer (CEE)  
Michigan Dept of Environmental Quality  
\$61,103 (9/1/2009 - 8/31/2011)

#### A) Statement of Water Quality Concern

Cladophora is a native, filamentous, green alga that grows attached to solid substrate in all of the Laurentian Great Lakes. Nuisance growth of Cladophora in the nearshore regions of Lakes Erie, Huron (Saginaw Bay) and Michigan have drawn the attention of those involved in public recreation, operation of utilities and water quality management. Public awareness of the problem has been heightened by reports in the popular press of beach fouling and the shutdown of nuclear power plants, concerns that incidences of avian botulism are linked to Cladophora and scientific studies linking Cladophora and human pathogens. This issue has recently been the focus of a bi-national working group supporting renewal of the Great Lakes Water Quality Agreement (GLWQA) and a eutrophication workshop sponsored by the International Joint Commission. Beyond its contribution to lost beneficial use, the issue is of particular significance to state regulatory authorities because the negative effects of the phenomenon are manifested in a manner and at locations that influence public perception of water quality.

It is well accepted that phosphorus, the growth-limiting nutrient, is the appropriate target for management of nuisance growth of Cladophora. Efforts to manage phosphorus loadings initiated in the J970s were effective in reducing nuisance growth. Colonization of the Great Lakes by dreissenids (zebra and quagga mussels) has markedly altered ecosystem dynamics with respect to Cladophora by increasing light penetration (yielding more substrate for colonization) and enhancing phosphorus cycling (making larger amounts of nutrients available). The resultant resurgence of Cladophora in the Great Lakes has become a top priority for environmental managers at levels ranging from the local communities impacted to bi-national policymakers. Reduction or elimination of nuisance growths will require further control of the amounts of phosphorus entering the nearshore waters of the Great Lakes.

The critical step in establishing target loads for phosphorus is to relate the magnitude of those loads to the amount of phosphorus ultimately available to Cladophora in its benthic habitat. It is here that the emerging role of dreissenids becomes significant as mussels process significant amounts of previously unavailable particulate (algal and soil) phosphorus, making that nutrient resource available to support Cladophora growth. The scientific basis for understanding this phenomenon is well established with respect to (J) the ability of dreissenids to generate a phosphorus flux to the water column and (2) the impact of water column phosphorus on Cladophora growth. It is the linkage between those scientific strengths that merits additional study, i.e. *taking into account the effects of turbulent mixing in the nearshore, what levels of phosphorus can be maintained in the water column?* We propose to provide that linkage by monitoring phosphorus concentrations in the water column above dreissenid beds in Saginaw Bay (Lake Huron), quantifying the ability of mussels to increase nutrient levels at locations colonized by Cladophora.

### 14. **Bioavailability and Phosphorus Management for Onondaga Lake**

PI: Auer, Martin (CEE)  
Upstate Freshwater Institute Inc  
\$85,555 (1/1/2010 - 8/31/2011)

#### *Background*

Section 303 of the Clean Water Act Amendments of 1977 requires identification of waters remaining polluted after the application of technology-based effluent limitations and subsequent determination of the Total Maximum Daily Loads (TMDLs) necessary to meet receiving water quality standards. As the nutrient most generally limiting algal growth in freshwater systems, phosphorus is the appropriate target for development of TMDLs in lakes where water quality is impacted by trophic state conditions. In evaluating the phosphorus TMDL for Onondaga Lake (NY), Effler et al. (2002) described a total effective phosphorus loading rate, i.e. one which quantifies the fraction of the phosphorus load that is actually available to support algal growth. The calculation takes into

account several factors ameliorating the loading impact on Onondaga Lake including plunging inflows, deposition of particulate phosphorus and the bioavailability of the dissolved and particulate phosphorus fractions. The authors concluded that the total effective phosphorus loading rate formed the appropriate basis for comparison of loading sources, especially with respect to their selection as targets for remediation activities.

The conclusions of Effler et al. (2002) are supported by the results of studies conducted on tributaries to the New York City drinking water supply system (Needham 2000) where the bioavailability of particulate phosphorus ranged from 14% (Schoharie Creek) to nearly 50% (West Branch of the Delaware River). Similarly dramatic results were obtained for tributary and point source discharges to Onondaga Lake. Not only was there evidence of enrichment in phosphorus bioavailability among inputs (Figure 1; Tomasoski 1997), but significant temporal variation in tributary phosphorus bioavailability was noted as well (Figure 2; Nover 2004). More recently, Effler et al. (2008) have demonstrated that accounting for bioavailability effects can change the ratio of the METRO: Tributary phosphorus load from 31%:69% to 57%:43%, a near doubling in the relative METRO contribution. For this reason, it is prudent to more carefully establish the total effective phosphorus loads for METRO and other sources as a prelude to consideration of further phosphorus management options.

#### *Proposed Research*

Here we propose to conduct ~50 phosphorus bioavailability assays on selected tributaries and point source inputs to Onondaga lake in support of the calculation of total effective phosphorus loads. Inputs to be assayed and the proposed frequency of sampling are identified in Table 1. Samples will be collected by Upstate Freshwater Institute and processed to yield a bioassay concentrate using tangential flow filtration. Samples will be shipped to Michigan Technological University where the assays will be performed using the Dual Culture Diffusion Apparatus (DCDA) method developed by DePinto (1982). This approach has been applied to municipal wastewater treatment effluents by Young et al. (1982), to tributaries to Great lakes waters by DePinto et al. (1981) and Young et al. (1985) and as described above to selected waters in New York. The DCDA (Figure 3) consists of a dark chamber containing the bioassay concentrate and a light chamber containing a population of phosphorus starved algae. The chambers are separated by an opaque 0.45  $\mu\text{m}$  filter. Bioavailable particulate phosphorus from the concentrate held in the dark chamber is solubilized and diffuses into the light chamber where it is taken up by the algae. The algae are periodically removed from the light chamber, assayed for their phosphorus content and replaced by fresh, phosphorus-starved algae. The quantity of bioavailable phosphorus produced is reflected in the change in the phosphorus content of the algae. The cumulative production of phosphorus over the course of the incubation represents the bioavailable phosphorus content of the sample and is expressed as a percentage of the initial total phosphorus (Figure 4). (References and Figures available upon request to [mtcws@mtu.edu](mailto:mtcws@mtu.edu))

#### 15. **PECASE: Integrated Modeling and Experimental Evaluations of Competition between PCE-Dehalogenating Populations: Implications for In Situ Bioremediation**

PI: Becker, Jennifer

National Science Foundation

\$9,354 (12/27/2009 - 2/28/2010)

##### (1) Monod Kinetic Parameter Determinations

###### *Intrinsic kinetic parameter estimates*

Intrinsic Monod kinetic parameters have been estimated for *Desulfuromonas michiganensis* strain BB J and *Desulfitobacterium* strain PCEL. Key findings resulting from this set of experiments have been published.

###### *Extant kinetic parameter estimates*

Previous studies point to the importance of the initial conditions in determining the amount of correlation between parameter estimates [2-5]. In particular, we were concerned about feasibility of obtaining independent several studies at the low initial substrate concentrations ( $S_0$ ) required for extant conditions because it has been suggested that it may be difficult to obtain independent estimates of the maximum specific substrate utilization rate ( $q_{\text{max}}$ ) and the half-saturation constant ( $K_s$ ) at small  $S_0/K_s$  ratios ( $S_0 < K_s$ ) [2, 5]. However, in general, previous studies are inconsistent with regard to their conclusions about how the initial conditions in batch kinetic assays ( $S_0/K_s$  and  $S_0/X_0$ , where  $X_0$  is the initial biomass concentration) affect the identifiability of parameter estimates.

In the current study, correlation coefficients ( $R^2$ ) were computed for numerically simulated batch PCE depletion for *Desulfuromonas michiganensis* under a wide range of initial conditions ( $0.025 \leq S_0/X_0 \leq 50$  and  $0.04 \leq S_0/K_s \leq 40$ ; Table I). This allowed us to unambiguously evaluate the relationship between  $S_0/K_s$  and parameter correlation at a constant  $S_0/X_0$ , as well as any effects of  $S_0/X_0$  on parameter correlation at constant  $S_0/K_s$ . The simulated kinetic parameter determinations are consistent with previous studies that suggest that independent estimates cannot be obtained at  $S_0/K_s < 1$  [2, 5]. Correlation coefficients ( $R^2$ ) of approximately 0.99 were

calculated for  $S_o/K_s = 1$ . Based on these results, choosing  $S_o = K_s$  as suggested by Ellis et al. [2], is also not recommended for estimation of independent parameters. While Table 1 clearly shows that, for a given  $S_o/X_o$  ratio, the amount of parameter correlation decreases with increasing  $S_o/K_s$ , increasing  $S_o/X_o$  does not reduce parameter correlation at a constant  $S_o/K_s$  ratio. These data suggested that in theory, it should be possible to obtain independent parameter estimates of  $q_{max}$  and  $K_s$  at the low  $S_o/X_o$  ratios required for extant kinetics, provided  $K_s$  is small enough to result in a large  $S_o/K_s$  ratio (10 or higher).

**16. Integrated Modeling and Experimental Evaluation of Hydrodynamic and Microbial Controls on DNAPL Dissolution and Detoxification**

PI: Becker, Jennifer

co-PI: Seagren, Eric

National Science Foundation

\$376,192 (12/28/2009 - 8/31/2012)

*Background.* In situ bioremediation based on biological reductive dehalogenation is now an established remediation approach for sites contaminated with aqueous-phase chlorinated ethenes. However, the EPA estimates that chlorinated ethenes are present as dense non-aqueous phase liquids (DNAPLs) at 46,000 contaminated sites in the U.S. The presence of DNAPL forms of these contaminants, which are known or suspected carcinogens, is a major obstacle to remediation efforts that has widespread implications for human and ecological health. Importantly, abiotic dissolution of DNAPLs into groundwater is a slow process and may require several hundred years to deplete the DNAPL source of contamination. Several in situ DNAPL treatment methods use physicochemical processes to mobilize and subsequently capture and/or destroy contaminants and thus accelerate the clean-up process. These methods can be difficult and costly to implement and may preclude bioremediation of dissolved contaminants by making conditions inhospitable to microorganisms. Recently, interest has grown in the use dehalorespiring bacteria to treat DNAPLs through bioenhanced dissolution, i.e., enhanced mass removal from chlorinated ethene DNAPLs through reductive dechlorination of dissolved contaminants near the DNAPL-water interface. This approach is appealing because it does not rely on DNAPL mobilization and is compatible with the clean-up of dissolved contaminants using bioremediation. Although bioenhanced dissolution appears promising, the design of biological DNAPL source treatment measures using a "black box" approach may not promote and sustain the growth of the populations with the greatest potential to bioenhance dissolution rates. The proposed project focuses on understanding the interrelated roles that hydrodynamics and competition among different dehalorespiring populations, as well as other community members, play in determining the distribution of dehalorespiring populations in the DNAPL source zone and dissolved contaminant plume and the resulting impact on the magnitude of bioenhanced dissolution and the extent of detoxification.

*Project Approach and Objectives.* Evaluation of the hydrodynamic and microbial controls on bioenhanced dissolution and detoxification of chlorinated ethenes will be accomplished using an integrated modeling and experimental approach that includes the following key objectives: (1) Mathematical modeling will be used to theoretically predict the relationships between microbial competition, hydrodynamic conditions, and bioenhancement for three model scenarios and design a micromodel system for studying DNAPL dissolution and source-zone microbial ecology at the porescale. (2) The micromodels will be used to independently estimate key system parameters and test model predictions for the three scenarios by experimentally evaluating the effects of microbial competition and hydrodynamics on population distribution, dissolution bioenhancement and plume detoxification. An innovative fluorescent in situ hybridization approach will be used to directly visualize and quantify population distribution in the micromodel. (4) An intermediate-scale flow cell will be used to test whether the micromodel experiments and mathematical modeling can predict bioenhancement effects in a scaled up system. (5) Mathematical modeling will be refined based on the experimental results and used to predict the effects of microbial competition and hydrodynamics on DNAPL source zone longevities for four DNAPL configurations.

**17. Great Lakes Maritime Education for K-12 Teachers**

PI: Chadde, Joan

University of Wisconsin-Madison

\$15,001 (9/1/2009 - 8/31/2010)

The Center for Science, Mathematics & Environmental Education at Michigan Technological University (MTU) requests support from GLMRI to continue & expand several of the successful Great Lakes Maritime Transportation education/outreach programs that have been implemented 2006-2008. Specifically, the Center proposes to conduct two summer teacher institutes--- a new institute on Mathematics & Navigation to be held at

MTU, and a new Great Lakes Maritime Transportation institute to be conducted at (and in partnership with) the Toledo Maritime Academy and University of Wisconsin in Madison. In addition, the Center proposes to conduct two teacher workshops during the school year. Possible locations are: Great Lakes Shipwreck Museum at Whitefish Point in Paradise, MI, the Michigan State Historical Museum in Lansing, Sturgeon Bay in Door County, or the Maritime Museum in Manitowoc, WI. The workshops will result in the development and publication of a lesson & activity guide on Great Lakes maritime transportation. Eight more Great Lakes maritime transportation education chests will be assembled and distributed to education/outreach institutions in the Great Lakes region (28 have been disseminated in the past 3 years).

#### 18. **Analysis of Hydrogeochemistry of Upland-Peatland Waterlands Using Isotopic Tracers**

PI: Mayer, Alex

US Dept of Agriculture

\$6,326 (5/20/2010 - 4/30/2011)

\$1,500 (5/20/2010 - 4/30/2011)

Approaches using oxygen and hydrogen isotopes have become a relatively standard techniques to trace water sources through ecosystems although few studies have utilizes isotopic approaches to discern water flow paths in peatlands. In one peatland type, bogs, water flows from the center of the bog (because it is domed) to edge of the bog to a zone called the "lagg". Associated hillslope waters from the upland also flow downslope to the lagg zone. Because bog waters and upland waters have very different chemistries, the lagg zone has been shown to be a biogeochemical hotspot .

Although much is known about the watershed hydrology of bog ecosystems, little is known about how the lagg interacts with upland and bog watershed components temporally or spatially. To further tease apart the hydrologic cycle and give us a better understanding of the spatial and temporal nature of the lagg, as well as help us better understand the upland vs. bog contributions at the watershed outlet, we will install an isotope study in the S2 watershed at the Marcell Experimental Forest in 2010.

Research questions include

- What proportion do various sources (upland subsurface runoff, upland surface runoff, peatland subsurface flow, precipitation) contribute to the flow at the wetland - upland interface (lagg zone)? How do the contributions vary under the following circumstances?
  - Convex vs. concave hillslopes
  - Rainfall events vs. dry periods
  - Seasonal variations
- How do the flow contributions from the different sources vary around the lagg zone to the watershed outlet?

#### 19. **A Linked Sediment-Water Column Model for Onondaga Lake**

PI: Auer, Martin

Upstate Freshwater Institute Inc

\$54,493 (1/1/2010 - 5/31/2011)

The Upstate Freshwater Institute is under contract to Onondaga County, New York to couple a sediment model (SED2K) with a water column model (UFILS4) for application to Onondaga Lake. The linked model will then be calibrated, validated, and applied in testing a suite of management scenarios with respect to Jake restoration. Michigan Tech will collaborate with UFI on this project by:

- providing model inputs, e.g. initial conditions, kinetic coefficients;
- providing data for model calibration and validation;
- participating in the calibration/validation process;
- participating in the execution of management runs; and
- preparing the final report

This award provides support for a graduate student who will collaborate directly with UFI personnel on these tasks.

20. **IDR: Collaborative Research: Sustainable Water Resources for Communities Under Climate Change: Can State-of-the-Art Forecasting Inform Decision-Making in Data Sparse Regions?**

PI: Mayer, Alex (CEE)

co-PIs: Halvorsen, Kathleen (SS/SFRES)

National Science Foundation

091213P2: \$317,389 (091213P2) [Project Start: 9/1/2010]

Intellectual Merit: Arid and semiarid regions may shoulder disproportional impacts of climate change due to the low resiliency and robustness inherent in both the natural and human infrastructure systems. One of the critical engineering systems threatened by climate change in these areas is water supply and its associated infrastructure. Imposing a warmer climate in a region of water scarcity may lead to unsustainable alternative future scenarios and further increase the complexity of water resources management. In this proposal, we intend to study decision-making for water resources management in anticipation of climate change in northern Mexico as a case study for the broader arid and semiarid southwestern North America. The goal of the proposed project is to determine whether water resources systems modeling, developed within a participatory framework, can contribute to the building of management strategies in a context of water scarcity, conflicting water uses and highly variable and changing climate conditions. Local stakeholders will be involved in guiding the design of supply- and demand-side management strategies and selection of climate change scenarios using state-of-the-art engineering tools. These tools include a water resources systems framework, a spatially-explicit hydrologic model, the use of forecasted climate scenarios under 21st century climate change, and observations obtained from field and satellite sensors. The participatory modeling approach will be conducted through a series of interactive workshops, carefully designed to encourage substantive participation from a broad range of stakeholders, including representatives from federal and local government agencies, water use sectors, non-governmental organizations, and academics. We will utilize the theory of planned behavior, which explains planned decisions, such as those made by water resource decision makers, as grounded in a suite of factors, including beliefs regarding risks, problems, and solutions. Through the theory of planned behavior, the participatory modeling process will be evaluated to understand if, and to what extent, the engineering tools are useful in the uncertain and politically-complex setting. Furthermore, the work will evaluate the sustainable outcomes emerging from the climate change scenarios and the potential adaptations that can be implemented in the decision-making process.

Broader Impacts: The proposed work combines engineering research with social and behavioral sciences for the purpose of evaluating sustainable water management outcomes in a semiarid region in a developing country. This approach undoubtedly challenges participants to carry out transformative, interdisciplinary research. We will engage three doctoral level students at MTU and ASU as well as undergraduate students for short-term research experiences. A focus on recruiting Hispanic students (with language skills) will facilitate interactions with local decision makers, regional stakeholders and the general public. Our team will build on prior work at ASU and MTU in water research within Mexico and other developing countries. In particular, we will bring the expertise and experience of the ASU School of Sustainable Engineering and the Built Environment and the MTU Center for Water and Society to bear on the problems of water supply under climate change threats. We will also work with several local universities in Sonora to develop an effective participatory modeling program. We expect that the results of this project will have an impact on water decision-making under climate change in the study area and provide a case study for replication in other data-sparse, semiarid regions.

21. **Predicting Ecosystem Changes in Lake Superior**

PI: Auer, Nancy (BIO)

co-PI: Auer, Martin (CEE)

US Environmental Protection Agency

100181P1: \$306,014 (9/1/2010 - 4/30/2013)

A linked hydrodynamic - nutrient food chain model will be expanded to include a bioenergetics submodel and applied to predict ecosystem changes in associated with climate change, variations in nutrient dynamics and alteration of food web structure (invasive species). A capacity to simulate the interplay of changes in energy resources (e.g. primary production) and energy sinks (e.g. predation and competition for food resources) will be developed and tested for benthic (*Diporeia* - lake whitefish) and pelagic (*Mysis*-rainbow smelt) food web components characteristic of Lake Superior.

22. **WSC-Category 1: Humans, Hydrology, Climate Change, and Ecosystems-An Integrated Analysis of Water Resources and Ecosystem Services in the Great Lakes Basin**

PI: Mayer, Alex (CEE)

co-PIs: Breffle, William; Halvorsen, Kathleen; Pypker, Thomas; Urban, Noel

National Science Foundation

100422P1: \$150,000 (9/1/2010 - 8/31/2012)

Water shortages will likely be exacerbated by climate change in water-scarce regions, but water-rich regions may get wetter. The Great Lakes region of North America is undeniably water-rich, but apprehension exists that water resources may be over-used. Policies for regulating water withdrawals and exports are evolving through the recently-passed binational Great Lakes Water Compact, including prescriptions for water conservation. The economic future of the region is uncertain and may be linked to expansion of potentially water-intensive sectors such as biofuel feedstock growth and processing. Shifts in water usage may bring about corresponding stresses on ecosystems. Climate change will bring about shifts in the hydrologic cycle that will also produce stress on aquatic ecosystems. If pressures on water resources intensify in the Great Lakes, will individuals and organization within this water-rich region modify their behavior to conserve water? **We propose to address this question by (a) developing integrated biophysical models for predicting ecosystem impacts due to future scenarios of land and climate change and (b) developing an understanding of how the region's groups and individuals view the regions' aquatic resources and what they believe are appropriate norms shaping human behavior vis a vis these water resources, especially as they relate to ecosystem services, and linking these assessments to interventions designed to shift their planned behavior with regard to regional water resources.**

The **long-range objectives** of this work are (1) to predict environmental impacts and associated losses of ecosystem values and services resulting from water quantity and quality alterations caused by future land development and climate changes; (2) to develop data collection protocols for evaluating community perceptions of the social impacts of climate induced biophysical impacts (participatory self-assessment); (3) to investigate possible social responses to predicted biophysical impacts and evaluate mechanisms for changing those responses; and (4) to develop policy scenarios for mitigating negative impacts that can in turn be evaluated by a diverse set of criteria. The immediate **objectives of the 1-year planning grant** are: (1) to refine research objectives and formulate key hypotheses, utilizing available databases and literature to inform in-depth analyses and dialogue by a team of researchers from the economic, social, and biophysical sciences; (2) to assess existing datasets for model inputs and calibration and verification efforts; (3) to test existing and hybrid biophysical and ecosystem impact modeling strategies on a few key watersheds; (4) to develop quantitative and qualitative social data collection tools for regionwide use; and (5) to develop a proposal for a full project. The **corresponding planning grant** activities will include (1) convening workshops with invited scientific experts and members of NGOs and state, federal and binational agencies; (2) hiring a post-doc to pull together existing models and databases to develop a predictive hydrologic-ecosystem model; and (3) developing and testing the social data collection tools. The data collection and modeling activities will be leveraged by ongoing work by the co-PIs on Great Lakes biogeochemical processes and human-ecological interactions.

Intellectual merit: This project builds upon our ability to understand and predict behavior of individual ecosystems and develops tools needed to predict responses of the regional landscape to future scenarios of altered climate and socioeconomic conditions. The models we develop will require innovations in integrating climate change and human activity drivers into coupled hydrologic-ecosystem services models. Our analysis of attitudes and beliefs surrounding human perception of the Great Lakes water resources will yield important insights into the norms that shape human activities with regard to these resources and how those norms can be shaped to solve water-related problems.

Broader impacts: This project will begin the training of one M.S. student, mentor one post-doctoral fellow, and develop an educational web-based module for use by the public and schools. The module will be disseminated through the co-PIs' ongoing, broad range of local, regional, and international K-12 water resource activities. Through MTU's graduate Water Resources Management Certificate, we will feature a series of team presentations in the graduate symposium on the climate change-related implications for Great Lakes management, policy, and human values. The project will develop new interdisciplinary connections between MTU departments and among multiple institutions. It will bring together academic researchers and policy makers to structure the research to produce outcomes useful for resource managers and public policy decision makers.

### **23. Virtual Water Accounting: A New Paradigm for the Adaptive Management of Great Lakes Water**

PI: Mayer, Alex (CEE)  
Co-PI: Huckins, Casey (BIO)  
Great Lakes Protection Fund  
100679P2: \$916,736, Awarded

This is a synthetic project to achieve the outcomes of (1) developing and proving a new scientific methodology relating economic production, watershed flow depletion, and ecosystem services, (2) pilot the new methodology to quantify these relationships in select HUC-12 scale watersheds and downstream watersheds in the Great

Lakes Basin, (3) work with an advisory board of policymakers, watershed advocates, and leaders of business and finance to determine the implications of these relationships for water and economic development policy, and (4) determine how this pilot project's findings could be further developed and implemented to inform Great Lakes Basin water policy, including future revisions to the Great Lakes Compact. Towards this end will implement a comprehensive communication plan, with the goal of gathering input from water policy stakeholder communities. The deliverable of this research will be a proof of concept and plan of implementation for a new approach to an integrated adaptive management of water resources in the Great Lakes Basin that accounts for the economic and environmental impacts of water uses. The project investigators include the primary personnel and an advisory committee consisting of technical and policy domain experts who will collaborate with the primary personnel.

**24. Evaluation of Suitability from Native Species Restoration in the 1836 Treaty Area with Prescriptions Developed for Arctic Grayling**

PI: Auer, Nancy (BIO)

co-PI: Huckins, Casey (BIO)

Little River Band of Ottawa Indians

1010065P1: \$149,999, Awarded

This project will develop a comprehensive native species restoration plan for the Little River Band of Ottawa Indians (LRBOI) Reservation and Big Manistee River watershed, running from 2010-2012. Specifically, we will evaluate historic and current conditions of local ecosystems for development of plans for the reintroduction of Arctic grayling (*Thymallus arcticus*) and elk (*Cervus elaphus*). The objectives of this project are to: 1) determine historic conditions in the Big Manistee River watershed when grayling and elk existed naturally, 2) summarize research on grayling and elk habitat parameters for all life stages, 3) determine present habitat conditions and abundance of species that may potentially interact with reintroduced species, and 4) develop prescriptions for re-establishing grayling and elk populations (a component of a native species management plan).

The grayling and elk both maintain historic cultural importance to the LRBOI and are considered cultural indicator species. In the 1800's both of these species were used for subsistence, and Tribal knowledge has been preserved and passed on regarding the value and handling of these species. This project will be an important component of capacity building of the LRBOI to restore cultural indicators to their rightful place in Tribal society and allow for the transfer of traditional values from generation to generation. The LRBOI has successfully managed the restoration of other cultural indicators, as evidenced by the Nme (Lake Sturgeon) Stewardship Plan for the Big Manistee River and 1836 Reservation. This dual-species restoration project is consistent with and supports numerous efforts throughout the Great Lakes (Great Lakes Restoration Initiative) and Michigan focused on restoring native species, such as, sturgeon (*Nme*), coaster brook trout (*Meegwas*), wild rice (*Manoomin*) and kiyi (*Atikameg*). This project will further enhance partnerships with management agencies and academic institutions, including the US Fish and Wildlife Service, US Forest Service, Environmental Protection Agency, and Michigan Technological University. These partnerships ultimately promote comprehensive management of natural resources and build Tribal capacity to manage for the needs of its members.

**25. Acoustic Measurement of Pipe Discharge Downstream of 90-degree Bend**

PI: Barkdoll, Brian (CEE)

South Florida Water Management District

1103051P1: \$49,203, Awarded

The Hydro Data Management (HDM) Division of the South Florida Water Management District (SFWMD) is responsible for developing equations and computing flows within the District's approximately 1,800 miles of canals and levees, 135 gated spillways, 400 culverts, and 60 pump stations. These data sets are used for many District activities including water quality analyses, flood control analyses, assessment of ecological restoration efforts, water supply analyses, regulation and permitting, and design of new water control structures.

Flows through these structures are obtained with equations that establish the relationship between the flow through the structure, the structure's geometry and operating conditions, and the water stages upstream and downstream of the structure. The development of these equations involves the use of known hydraulic and fluid mechanics principles, manufacturer's pump rating curves, and curve-fitting using in-situ flow measurements.

To improve the accuracy of the flow estimates at a specific structure, the equations are revised through a rating calibration, for which direct flow measurements from stream-gauging are required. A variety of instruments are used for stream-gauging, which are based on different operating principles that stem from various physical, optical, acoustical, and mechanical characteristics. Typical instruments used at the District for stream-gauging include current meters and acoustic Doppler current profilers (ADCPs).

Difficulties exist in measuring discharge at pumping stations since pump performance curves are not always available or may not be accurate. To improve upon the accuracy of vendor-provided pump performance curves, a method of measuring discharge in the pump discharge pipe is desirable. Commercially-available discharge meters assume a velocity profile in the pipe corresponding to that in a straight section of pipe in which the flow is fully developed. This requires a location along the pipe a long distance downstream from any change in flow direction (i.e., pipe bend). In the District pump stations, however, pipe bends are located closely together and, therefore, do not allow for the application of such meters in full compliance with vendor specifications.

Professor Roger Turpening (Michigan Technological University), has successfully captured profiles with circular cross sections using acoustic-based measurement methods. While Professor Turpening's work has focused primarily in the field of the Geophysical Engineering, it is expected that the methods and algorithms are closely related to the needs of the District to measure turbulent water flow in a circular pipe downstream of a 90° bend. For the purpose of this investigation, Professor Turpening will work closely with Professor Brian Barkdoll (MTU) to demonstrate the ability to accurately capture the velocity field in a pipe downstream of a 90° bend using an existing flume in Professor Barkdoll's laboratory.

The objective of this project is to refine existing acoustic technology to generate fluid -flow profiles with circular, turbulent cross-sections downstream of a 90-degree bend.

**26. Evaluation of Larval Lake Sturgeon Production on Fighting Island Reef in the Detroit River**

PI: Auer, Nancy (BIO)

US Dept of the Interior

100684P1: \$ 60,611 (2/18/2011 - 9/30/2012)

This research project capitalizes on an opportunity to discover important new information regarding lake sturgeon (*Acipenser fulvescens*) ecology and the response of native fish populations to habitat restoration efforts. These types of information are critical for the design, implementation, and assessment of future fisheries management strategies directed toward restoration of native fish habitat within and beyond the Great Lakes basin. Efforts to rehabilitate fisheries habitat rely on knowledge of habitat availability and function to use as a benchmark for restoration goals. In addition, scientists require an understanding of how the habitat functions in its current state in order to set restoration goals and assess the effectiveness of restoration strategies. In 2010, 2011, and 2012 we will employ passive drift samplers and active bongo samplers below Fighting Island reef during the period one week prior to and for one month after expected emergence occurs to assess 1) density and abundance of larval lake sturgeon, 2) phenology and chronology of larval lake sturgeon drift, 3) size and growth of lake sturgeon larvae, and 4) histological assessment of head and brain morphology. Field sampling durations will be adjusted to minimize larval mortality so that most lake sturgeon larvae can be returned to the system after biological measurements are made.

**27. Great Lakes Maritime Education for K-12 Teachers**

PI: Chadde, Joan (CEE)

University of Wisconsin - Madison

1012026P1: \$15,000 (10/1/2010 - 9/30/2011)

The Center for Science & Environmental Education Outreach at Michigan Technological University (MTU) requests support from GLMRI to continue and expand several of the successful Great Lakes Maritime Transportation education/outreach programs that have been implemented 2006-2010. The Center will partner with the National Center for Freight & Infrastructure Research and Education (CFIRE) at the University of Wisconsin-Madison (<http://cfire.wistrans.org>).

The Center proposes to conduct two summer teacher institutes-Mathematics & Navigation to be held at Michigan Tech using the research vessel Agassiz, and a Great Lakes Maritime Transportation institute in Door County, Wisconsin. In addition, the Center proposes to conduct two 1-day elementary teacher workshops during the school year in Michigan, Wisconsin, Minnesota, or Ohio. The workshops will result in the development of a lesson & activity guide on Great Lakes maritime transportation. Eight more Great Lakes maritime transportation education teaching chests will be assembled and distributed to education/outreach schools, museum, and institutions in the Great Lakes region.

**28. Great Lakes Maritime Education for K-12 Teachers**

PI: Chadde, Joan (CEE)

University of Wisconsin - Superior  
100611P2: \$15,000 (10/1/2010 - 9/30/2011)

The Center for Science & Environmental Education Outreach at Michigan Technological University (MTU) requests support from GLMRI to continue and expand several of the successful Great Lakes Maritime Transportation education/outreach programs that have been implemented 2006-2010. The Center will partner with the National Center for Freight & Infrastructure Research and Education (CFIRE) at the University of Wisconsin-Madison (<http://cfire.wistrans.org>).

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**29. Upgrade to MTU Sediment Collection Capabilities**

PI: Alex Mayer  
REF-IE program  
1106069P1: \$20,000

Funding is sought for the acquisition of a sediment multi-corer (\$23,500), upgrading of existing sediment traps (\$20,470), and enhancement of the davit (\$5,000) on the R/V Agassiz. The multi-corer is the instrument of choice for oceanographic and large lake sediment collection. To deploy this unit from the MTU research vessel (R/V Agassiz) the existing davit must be modified. The primary modification required is greater height. MTU currently owns two high quality sediment traps, but these units are now 11 years old, and are in need of upgrading and servicing to render them operable. These units also cannot be deployed from the R/V Agassiz without modification of the davit. By modifying the davit, we will be able to use MTU's own research vessel rather than paying for other ships; not only will this keep research funds at MTU but it will make proposals more competitive because it costs less to use the R/V Agassiz than the larger Great Lakes research vessels.

This equipment is essential to making MTU competitive in grants for Great Lakes research. These competitive abilities will also enhance the stature of the Great Lakes Research Center now under construction. Considerable funding is currently available for Great Lakes work through the Great Lakes Restoration Initiative (GLRI) and Great Lakes Legacy Act; this funding is being funnelled to groups with demonstrated capability to perform work quickly. MTU has not been competitive in this program to date because of a lack of equipment needed to perform restoration and research in support of remediation.

### **5.3 *Proposals Submitted under CWS, 2010-11***

1. Virtual Water Accounting: A New Paradigm for the Adaptive Management of Great Lakes Water  
PI: Mayer, Alex (CEE)  
Co-PI: Huckins, Casey (BIO)  
Great Lakes Protection Fund  
100679P2: \$916,736, Awarded
2. RCN: Linking Great Lakes and Small Streams (GLaSS)  
PI: Marcarelli, Amy (BIO)  
Northern Michigan University  
100685P1: \$31,500
3. Diversity of Great Lakes Basin Fishes, Influenced by Invasive Species, Using Larval Stages as Identification  
PI: Auer, Nancy (BIO)  
National Science Foundation  
1007006P1: \$690,233
4. NCHRP Synthesis 20-05/Topic 42-09 Low Cost Solutions for Stabilization and Erosion Control  
PI: Barkdoll, Brian (CEE)  
National Academy of Sciences  
1008013PP: \$35,000
5. Evaluation of Suitability from Native Species Restoration in the 1836 Treaty Area with Prescriptions  
Developed for Arctic Grayling  
PI: Auer, Nancy (BIO)  
co-PI: Huckins, Casey (BIO)  
Little River Band of Ottawa Indians  
1010065P1: \$149,999, Awarded
6. Experimental Frameworks for Evaluating the Net Effects of Hydrological Service Payments on Coupled  
Social-ecological Systems in Mexico  
PI: Halvorsen, Kathleen (SFRES)  
co-PI: Mayer, Alex (CEE)  
University of New Hampshire  
1012016P1: \$508,513
7. Wetland and Stream Restoration within Seney NWB  
PI: Pypker, Thomas (SFRES)  
Co-PIs: Chimner, Rodney (SFRES), Mayer, Alex (CEE)  
National Fish and Wildlife Foundation  
1102021PP: \$138,816
8. CI-TEAM Demo: Environmental CyberCitizens: Engaging Citizen Scientists in Global Environmental Change  
through Crowdsensing and Visualization  
PI: Mayer, Alex (CEE)  
National Science Foundation  
1103036P1: \$249,840
9. Acoustic Measurement of Pipe Discharge Downstream of 90-degree Bend  
PI: Barkdoll, Brian (CEE)  
South Florida Water Management District  
1103051P1: \$49,203, Awarded
10. Regional Frequency Analysis of Hydrologic Extremes Informed by Climate and Land Surface Data  
PI: Griffis, Veronica (CEE)  
Co-PIs: Brooks, Colin (MTRI), Watkins, David (CEE)  
National Aeronautics Space Administration  
1103053P1: \$291,832

11. Effects of Extreme Events on Water Quality in the Coastal Great Lakes  
PI: Urban, Noel (CEE)  
co-PIs: Griffis, Veronica (CEE), Mayer, Alex (CEE), Watkins, David (CEE)  
US Environmental Protection Agency  
1104016P1: \$748,214
12. Integrated Assessment of Torch Lake AOC  
PI: Urban, Noel (CEE)  
co-PIs: MacLennan, Carol (SS), Perlinger, Judith (CEE)  
UNIVERSITY OF MICHIGAN-MICH SEA GRANT  
1104023P1: \$ 119,339
13. Inventory of Mining Impacted Streams in the Coastal Zone of the Keweenaw  
PI: Urban, Noel (CEE)  
co-PI: Kerfoot, W Charles (BIO)  
Michigan Dept of Environmental Quality  
1105024P1: \$55,560
14. Changes in Ecosystem Function Associated with Sand Accumulation in a Lake Superior Tributary  
PI: Marcarelli, Amy (BIO)  
co-PI: Huckins, Casey (BIO)  
US Dept of Agriculture  
1106039P1: \$11,633
15. Upgrade to MTU Sediment Collection Capabilities  
PI: Alex Mayer  
REF Infrastructure Enhancement Grant  
1106069P1: \$49,370

## 6 Publications by CWS Participants, 2010-11

This listing includes publications by CWS members that are relevant to water-related issues. Publications are ordered by first author and include journal articles, books, and chapters in books that are published, in press, or accepted. Items which are in press or accepted will be counted as published with complete references in the next CWS Annual Report.

Published journal articles, books, and book chapters .....	62
Other Publications.....	8
Proceedings.....	6
Journal articles, books, chapters, and proceedings accepted .....	17
Presentations .....	59
FY 2009-10 references which completed publication in 2010-11 .....	10

### 6.1 Publications (*Published or Accepted*)

#### 6.1.1 Book

1. 2011, "The Great Lake Sturgeon", editors: **Auer, N.**, Dempsey, D., MSU press, Lansing, MI, *Accepted*.
2. **Gorman, Hugh S.**, 2010, "The Story of N: A Social History of Nitrogen Cycle and the Challenge of Sustainability", Rutgers University Press, *Accepted*.
3. **Hand, David W.**, Hokanson, David R., Crittenden, John C., 2010, "Chapter 6. Gas Transfer: Principles and Applications", Water Quality and Treatment, 6th Edition, American Water Works Association, McGraw-Hill, New York, NY, No. 6th edition, ISBN/ISSN 978-0-07-163011-5, *Published*.

#### 6.1.2 Book, Chapter in

1. **Chimner, Rodney A.**, Cooper, D J., 2011, "Fens of the San Juan Mountains", editors: Chimner, R., Eastern San Juan Mountains, Colorado: Geology, Ecology and Human History, *Published*.
2. Cooper, D J., **Chimner, Rodney A.**, Merritt, D M., 2011, "Mountain Wetlands of North America", editors: Chimner, R., Wetland Habitats of North America: Ecology and Conservation Concerns, *Published*.
3. **Hand, David W.**, **Zhang, Qiong**, Mihelcic, James M., 2010, "Chapter 10: Water Treatment", editors: Mihelcic & Zimmerman, Environmental Engineering: Fundamentals, Sustainability, Design, John Wiley & Sons, No. 2nd, pages 396-460, ISBN/ISSN ISBN-13 978-0-470-16505-8, *Published*.
4. Mihelcic, James M., **Hand, David W.**, **Auer, Martin T.**, 2010, "Chapter 11: Wastewater Treatment", editors: Mihelcic & Zimmerman, Fundamentals of Environmental Engineering, John Wiley & Sons, New York, NY, No. 2nd, pages 460 - 517, ISBN/ISSN ISBN-13 978-0-470-16505-8, *Published*.

5. Mihelcic, James R., **Urban, Noel R., Perlinger, Judith A.**, 2010, "Chemistry", editors: Mihelcic, J., Zimmerman, J., Environmental Engineering: Fundamentals, Sustainability, Design, Wiley Interscience, New York, NY, pp. 52-104, *Published*.
6. **Mirchi, Ali, Watkins, David W.**, Madani, Kaveh, 2010, "Modeling for Watershed Planning, Management, and Decision Making", editors: Vaughn, J., Watersheds: Management, Restoration and Environmental Impact, Nova Science Publishers, Inc., ISBN/ISSN 978-1-61728-243-0, *Published*.
7. **Orr, Blair D.**, 2009, "Participatory Approaches to Engineering Projects", editors: Mihelcic, J., Water Supply, Sanitation Systems, and Indoor Air Quality: Field Guide in Engineering for Development Workers, ASCE (American Society of Civil Engineers) Press, ISBN 978-0-7844-0985-5, *Published*.
8. **Pypker, Thomas G.**, Levia, D F., Staelens, J, Van Stan, J T., 2011, "Chapter XVII. Canopy structure in relation to hydrological and biogeochemical fluxes", editors: Pypker, T., Forest Hydrology and Biogeochemistry: Synthesis of Past Research and Future Directions. Ecological Studies Series, Springer-Verlag, Heidelberg, Vol. 216, *Accepted*.
9. Scott, J. T., **Marcarelli, Amy M.**, 2011, "Cyanobacteria in freshwater benthic environments", editors: Whitton, B., The Ecology of Cyanobacteria, 2nd edition, Springer, Dordrecht, *Accepted*.

### 6.1.3 Journal Article

1. Anderson, Mark J., **Barkdoll, Brian D.**, 2010, "Incorporation of Air Emissions in Dredging Method Selection", Journal of Waterway, Port, Coastal and Ocean Engineering, ASCE, Reston, VA, Vol. 136, No. 4, July/August 2010, pp 191-199 ([doi http://dx.doi.org/10.1061/\(ASCE\)WW.1943-5460.0000039](http://dx.doi.org/10.1061/(ASCE)WW.1943-5460.0000039)), *Published*.
2. **Auer, Martin T.**, Bub, L. A., **Auer, Nancy A., Urban, Noel R.**, 2010, "Primary production, carbon flux and the distribution of the amphipod Diporeia in Lake Superior", International Association of Theoretical and Applied Limnology, Stuttgart, Vol. 30, No. 10, 1499-1505, *Published*.
3. **Breffle, William S.**, Morey, E. R., Thacher, J., 2010, "A joint latent-class model: combining Likert-scale preference statements with choice data to harvest preference heterogeneity", Environmental and Resource Economics, *Accepted*.
4. Bruning, Jill, **Gierke, John S.**, Maclean, Ann L., 2010, "An Approach to Lineament Analysis for Groundwater Exploration in Nicaragua", editors: Gierke, J., Photogrammetric Engineering & Remote Sensing, American Society for Photogrammetry and Remote Sensing, Bethesda, MD, Vol. 77, No. No 5, pp. 509-519, ISBN/ISSN 0099-1112/11/7705-0509, *Accepted*.
5. **Campbell, Gary A.**, Roberts, Mark C., 2010, "Permitting a New Mine: Insights from the Community Debate", editors: Philip Maxwell, Resources Policy, Elsevier, Amsterdam, Vol. 35, No. 3, 210-217, *Published*.
6. **Cavaleri, Molly A.**, Sack, Lawren, 2010, "Comparative water use of native and invasive plants at multiple scales: a global meta-analysis", Ecology, Vol. 91, 2705-2715, *Published*.
7. Chestnut, Lauraine G., Rowe, Robert D., **Breffle, William S.**, 2011, "Economic valuation of mortality risk reduction: stated preference estimates from the U.S. and Canada", Contemporary Economic Policy, *Accepted*.

8. **Chimner, Rodney A.**, Welker, J M., J M., LeCain, D, Reader, J, 2010, "Experimental Manipulations of winter snow and summer Rain Influence Ecosystem Carbon Cycling in a Mixed-grass Prairie, Wyoming, USA.", editors: Chimner, R., *Ecohydrology*, Vol. 3, 284-293, *Published*.
9. **Chimner, Rodney A.**, Cooper, D J., Lemly, J M., 2010, "Mountain fen distribution, types and restoration priorities, San Juan Mountains, Colorado, USA.", editors: Chimner, R., *Wetlands*, Vol. 30, 763-771, *Published*.
10. Chou, Chiung-Wen, **Seagren, Eric A.**, Aydilek, Ahmet H., Lai, Michael, 2011, "Biocalcification of sand through ureolysis", *Journal of Geotechnical and Geoenvironmental Engineering (ASCE)*, American Society of Civil Engineers, Reston, VA, *Accepted*.
11. Cooke, Colin A., Balcom, Prentiss H., **Kerfoot, W. Charles**, Abbott, Mark B., Wolfe, Alexander P., 2011, "Pre-Columbian Mercury Pollution with the Smelting of Argentiferous Ores in the Bolivian Andes", *AMBIO*, Vol. 40, 18-25, *Published*.
12. Demirkan, M. M., Aydilek, Ahmet H., **Seagren, Eric A.**, Hower, John C., 2011, "Naphthalene and o-xylene adsorption onto high carbon fly ash", *Journal of Environmental Engineering (ASCE)*, American Society of Civil Engineers, Reston, VA, Vol. 137, No. 5, 377-387, *Published*.
13. Donofrio, Robert, Bestervelt, Lorelle, Saha, Ratul, **Bagley, Susan T.**, 2010, "Quantitative Real Time PCR and Fluorescent in situ Hybridization Approaches for Enumerating *Brevundimonas diminuta* in Drinking Water", *Journal of Industrial Microbiology and Biotechnology*, Springer, Volume 37, Number 9, Pages 909-918, *Published*.
14. Eckman, B., Feblowitz, M., **Mayer, Alex S.**, Riabov, A., 2010, "Toward an integrative software infrastructure for water management in the Smarter Planet", *IBM Journal of Research and Development*, Vol. 54, 1-20, *Published*.
15. **Fry, Lauren M., Cowden, Joshua, Watkins, David W.**, Clasen, Thomas, Mihelcic, James R., 2010, "Quantifying Health Improvements from Water Quantity Enhancement: An Engineering Perspective Applied to Rainwater Harvesting in West Africa", *Environmental Science and Technology*, Vol. 44, No. 24, 9535-9541, *Published*.
16. **Fuchs, Valerie**, Mihelcic, James R., **Gierke, John S.**, 2011, "Life cycle assessment of vertical and horizontal flow constructed wetlands for wastewater treatment considering greenhouse gas emissions", *Water Research*, Vol. 45, No. 5, 2073-2081, ISBN/ISSN doi: 10.1016/j.watres.2010.12.021, *Published*.
17. **Ghimire, Santosh R., Barkdoll, Brian D.**, 2010, "Sensitivity Analysis of Municipal Drinking Water Distribution System Energy Use to System Properties", *Urban Water Journal*, Tayler and Francis, UK, Volume 7, Issue 4, August 2010, pages 217-232, *Published*.
18. Hallack-Alegria, Michelle, Ramirez, Jorge, **Watkins, David W.**, 2011, "ENSO-Conditioned Rainfall Drought Frequency Analysis in Northwest Baja California, Mexico", *International Journal of Climatology*, *Accepted*.
19. **Harless, M L., Huckins, Casey J.**, Grant, J B., **Pypker, Thomas G.**, 2011, "Effects of six chemical deicers on larval wood frogs", editors: Pypker, T., *Environmental Toxicity and Chemistry*, *Accepted*.
20. Homola, Jared J., Scribner, Kim T., Elliot, Robert F., Donofrio, Michael C., Baker, Edward A., **Auer, Nancy A.**, 2010, "Genetic assessment of straying rates for wild and hatchery lake sturgeon and occupancy of riverine habitats during non-spawning periods.", *Journal of Great Lakes Research*, *Published*.

21. Hopkins, Jessica M., **Marcarelli, Amy M.**, Bechtold, Heather A., 2011, "Ecosystem structure and function are complementary measures of water quality in a polluted, spring-influence river", *Water Air and Soil Pollution*, Vol. 214, 409-421, *Published*.
22. Huang, Deyang, **Becker, Jennifer G.**, 2011, "Dehalorespiration Model That Incorporates the Self-Inhibition and Biomass Inactivation Effects of High Tetrachloroethene Concentrations", *Environmental Science & Technology*, Vol. 45, No. 3, 1093-1099, *Published*.
23. Jensen, J.E., **K.E. Halvorsen**, D.R. Shonnard. 2011. Cellulosic Ethanol, U.S. Federal Energy and Agricultural Policy, and the Diffusion of Innovation. Special Issue: Socioeconomic Dimensions of U.S. Bioenergy. *Biomass and Bioenergy* 35(4)1454-1464.", *Published*.
24. **Kerfoot, W. Charles**, McNaught, A. Scott, 2010, ""Two-step" Dialogue Between The Cladoceran *Bosmina* And Invertebrate Predators: Induction And Natural Selection", *Limnology & Oceanography*, Vol. 55, No. 1, 403-419, *Published*.
25. **Kerfoot, W. Charles, Yousef, Foad, Green, Sarah A.**, Budd, Judith W., Scwab, David J., Vanderploeg, Henry A., 2010, "Approaching Storm: Pelagic Productivity Collapse In Lake Michigan?", *Journal of Great Lakes Research*, Vol. 36, 30-41 doi:10.1016/j.jglr.2010.04.010, *Published*.
26. Kolkka, Robert W., Giardina C., McClure J., **Mayer, Alex S.**, Jurgensen, Martin F., 2010, "Partitioning hydrologic contributions to an 'old-growth' riparian area in the Huron Mountains of Michigan, USA", *Ecohydrology*, DOI: 10.1002/eco.112, 2010, *Published*.
27. LeFevre, Nancy-Jeanne B., **Watkins, David W., Gierke, John S.**, Brophy-Price, Jennifer, 2010, "Hydrologic Performance Monitoring of an Underdrained Low-Impact-Development Stormwater Management System", *Journal of Irrigation and Drainage Engineering*, Vol. 136, No. 5, 333-339, ISBN/ISSN doi: 0733-9437/2010/5-33-339, *Published*.
28. Li, Bowen, Hwang, Jiann-Yang, Drelich, Jaroslaw, Popko, Dominic, **Bagley, Susan T.**, 2010, "Physical, Chemical and Antimicrobial Characterization of Copper-bearing Material", *JOM, USA*, Vol. 62, No. 12, 80-85, *Published*.
29. Licata, Julian, **Pypker, Thomas G.**, Weigandt, M, Unsworth, Michael H., Gyenge, J E., Fernandez, M E., Schichter, T M., Bond, Barbara J., 2011, "Decreased rainfall interception balances increased transpiration in exotic ponderosa pine plantations compared with native cypress stands in Patagonia, Argentina.", *Ecohydrology*, Vol. 4, 83-93, *Published*.
30. Mann, Kevin A., Holtgren, John M., **Auer, Nancy A.**, 2011, "Lake sturgeon growth and movement in early life in the Big Manistee River, Michigan", *North American Journal of Fisheries Management*, Bethesda, MD, *Published*.
31. **Marcarelli, Amy M.**, Baxter, Colden V., Mineau, Madeleine M., Hall, Robert O., 2011, "Quantity and quality: unifying food web and ecosystem perspectives on the role of resource subsidies in freshwaters", *Ecology*, Vol. 92, No. 6, 1215-1225, *Accepted*.
32. **Marcarelli, Amy M.**, Van Kirk, Robert W., Baxter, Colden V., 2010, "Predicting effects of hydrologic alteration and climate change on ecosystem metabolism in a western U.S. river", *Ecological Applications*, Ecological Society of America, Vol. 20, No. 8, 2081-2088, *Published*.
33. McCray, John E., Tick, Geoffrey R., Jawitz, James W., **Gierke, John S.**, Brusseau, Mark L., Falta, Ronald W., Knox, Robert C., Sabatini, David A., Annable, Michael D., Harwell, Jeffery H., Wood, A L., 2011, "Remediation of NAPL Source Zones: Lessons Learned from Field Studies at Hill and Dover AFB", editors: Gierke, J., *Ground Water*, Wiley, Vol. 49, ISBN/ISSN doi: 10.1111/j.1745-6584.2010.00783.x, *Published*.

34. Mineau, Madeleine M., Baxter, Colden V., **Marcarelli, Amy M.**, 2011, "A non-native riparian tree (*Elaeagnus angustifolia*) changes nutrient dynamics in streams", *Ecosystems*, Vol. 14, No. 3, 353-365, *Published*.
35. **Munoz Hernandez, Andrea, Mayer, Alex S., Watkins, David W.**, 2010, "Integrated Hydrologic-Economic-Institutional Model of Environmental Flow Strategies for the Rio Yaqui Basin, Sonora, Mexico", *Journal of Water Resources Planning and Management*, ASCE, USA, Vol. 137, 227–237, *Published*.
36. Nesbitt, Susan, **Mayer, Alex S.**, 2010, "Shifting attitudes: The effects of field trip experiences on student beliefs", *Transformative Dialogues*, Vol. 4, No. 2, 1-22, *Published*.
37. Nizzetto, L., MacLeod, M., Cabrerizo, A., Dachs, J., Di Guardo, A., Ghirardello, D., Hansen, K. M., Jarvis, A., Lindroth, A., Ludwig, B., Monteith, D., **Perlinger, Judith A.**, Scheringer, M., Schwendenmann, L., Semple, K. T., Wick, L. Y., Zhang, G., Jones, K. C., 2010, "Past, present and future controls on levels of persistent organic pollutants in the global environment", *Environ. Sci. Technol.*, American Chemical Society, Vol. 44, 6526-6531, *Published*.
38. Packalen, Maara, **Bagley, Susan T.**, McLaughlin, James, 2010, "Peatland stream lipid biogeochemistry features in an intermediate fen peatland, Ontario, Canada", *Wetlands*, Canada, Vol. 31, No. 2, 353-365, *Accepted*.
39. Pingel, Nathan, **Watkins, David W.**, 2010, "Multiple Flood Source Expected Annual Damage Computations", editors: Daene McKinney, *Journal of Water Resources Planning and Management*, ASCE, Reston, VA, Vol. 136, No. 3, 319-326, *Published*.
40. **Robles Morua, Agustin, Halvorsen, Kathleen E., Mayer, Alex S.**, 2010, "Waterborne disease-related risk perceptions in the Sonora River Basin, Mexico", *Risk Analysis*, *Accepted*.
41. **Rowe, M D., Perlinger, Judith A.**, 2010, "Performance of a high flow-rate, thermally-extractable diffusion denuder for semivolatile organic chemical atmospheric concentration measurement", *Environ. Sci. Technol.*, American Chemical Society, Vol. 44, No. 6, 2098–2104, *Published*.
42. **Rowe, Mark D., Perlinger, Judith A.**, 2010, "Prediction of gas collection efficiency and particle collection artifact for atmospheric semivolatile organic compounds in multicapillary denuders", *J. Chromatogr. A*, Vol. 1217, 256-263, *Published*.
43. Rucinski, Daniel, **Watkins, David W., Auer, Martin T.**, Effler, Steve, O'Donnell, David M., 2010, "A Dual Discharge Approach to Accessing Assimilative Capacity: Probabilistic Analysis and Management Application", *Journal of Environmental Engineering*, ASCE, Reston, VA, Vol. 136, No. 7, 666-673, *Published*.
44. Saha, Ratul, Donofrio, Robert, **Bagley, Susan T.**, 2010, "Quantitative real-time PCR detection of *P. oleovorans* subsp. *lubricantis* using TaqMan-MGB assay in contaminated metalworking fluids", *International Biodeterioration and Biodegradation*, Great Britain, Vol. 65, No. 3, 460-464, *Accepted*.
45. Saha, Ratul, Donofrio, Robert, **Bagley, Susan T.**, 2010, "Detection of Microorganisms in Metalworking Fluids using Molecular Techniques", editors: Elizabeth Elder, *SIM News*, Society for Industrial Microbiology, US, Vol. 60, No. 3, 80-86, *Published*.
46. **Seagren, Eric A.**, Davis, Allen P., 2010, "Integrating fundamental science and engineering concepts into a civil engineering sustainability course", *Journal of Professional Issues in Engineering Education and Practice* (ASCE), American Society of Civil Engineers, Reston, VA, *Accepted*.

47. Tarasoff, Catherine S., Ball, Daniel A., **Pypker, Thomas G.**, Mallory-Smith, Carol A., Irvine, Kathy M., 2010, "Site characteristics associated with Nutall's and weeping alkaligrass in northeastern Oregon", editors: Pypker, T., Northwest Science, USA, Vol. 84, 351-360, *Published*.
48. **Wei, Wenge, Watkins, David W.**, 2010, "Probabilistic Streamflow Forecasts Based on Hydrologic Persistence and", Journal of Hydroinformatics, IWA Publishing, *Accepted*.
49. Zhang, Lan, **Seagren, Eric A.**, Davis, Allen P., Karns, Jeffrey S., 2011, "Long-term sustainability of Escherichia coli removal in conventional bioretention Media", Journal of Environmental Engineering (ASCE), American Society of Civil Engineers, Reston, VA, *Accepted*.
50. Zhang, Lan, **Seagren, Eric A.**, Davis, Allen P., Karns, Jeffrey S., 2010, "The capture and destruction of Escherichia coli from simulated urban runoff using conventional bioretention media and iron oxide-coated sand", Water Environment Research, Water Environment Federation, Alexandria, VA, Vol. 82, No. 8, 701-714, *Published*.

#### 6.1.4 Other Publications

1. 2010, "Developing methods for restoring fens in the San Juan National Forest, Colorado", editors: **Chimner, R.**, 44, *Published*.
2. 2011, "Special Issue: Socioeconomic Dimensions of US Bioenergy Development", editors: **Halvorsen, K.**, Selfa, T., Becker, D., Hinrichs, C., Socioeconomic Dimensions of US Bioenergy Development, Vol. 35, No. 4, *Published*.
3. Barnard, H R., Brooks, J R., **Pypker, Thomas G.**, McDonnell, J J., Bond, B J., Williams, D G., 2010, "Examining the linkages between forest water use, hydrology, and climate using dual-isotope approaches: insights and challenges in headwater catchments", editors: Pypker, T., EOS Transactions, Vol. 91, No. 52, Abstract H54B-01, *Published*.
4. **Breffle, William S.**, Mukherjee, Amlan, Donovan, Richard P., Jin, Yongliang, Liu, Fangming, 2010, "Assessing the Carrying Capacity of the Great Lakes Environment: A Lake Michigan Pilot Study", The Colcom Foundation, Pittsburgh, PA, 115, *Published*.
5. **Gorman, Hugh S.**, 2010, "The Nitrogen Cycle", Encyclopedia of Geography, SAGE, 2028-2029, *Published*.
6. Kane, Evan S., Mazzoleni, Lynn R., Kratz, C J., Hribljan, J A., Johnson, C P., **Pypker, Thomas G.**, **Chimner, Rodney A.**, 2010, "Dissolved organic carbon in peat porewater increases with warming: a field manipulation experiment in a northern temperate bog", editors: Pypker, T., EOS Transactions, Vol. 91, No. 52, B23E-0425, *Published*.
7. Resh, Sigrid, **Chimner, Rodney A.**, **Schrank, Amy J.**, Previant, W, 2011, "Vernal Pools in Pictured Rocks National Lakeshore", editors: Chimner, R., Final Report to Pictured Rocks National Lakeshore, *Published*.
8. **Richardson, J P.**, **FitzGerald, K A.**, **Pennington, Wayne D.**, 2010, "Ice-generated seismic events observed at the Bering Glacier, in Bering Glacier: Interdisciplinary Studies of Earth's Largest Temperate Surging Glacier", editors: Shuchman, R., Josberger, E., Bering Glacier: Interdisciplinary Studies of Earth's Largest Temperate Surging Glacier, Geological Society of America, Boulder, CO, Vol. Special Paper 462, ISBN/ISSN 978-0-8137-2462-1, *Published*.

### 6.1.5 Proceedings

1. **Campbell, Gary A.**, Walck, Christa L., Hartingh, Anne, 2010, "Conflict over the Sustainability of Copper Mining: Experiences from MI & WI", Proceedings-Copper 2010, GDMB, Hamburg, Vol. 1, 351-364, ISBN/ISSN 978-3-940276-25-4, *Published*.
2. **Fry, Lauren, Watkins, David W.**, Mihelcic, James, Reents, Nathan, 2010, "Sustainability of Gravity-Fed Water Systems in Alto Beni, Bolivia: Preparing for Change", ASCE World Environmental and Water Resources Congress, American Society of Civil Engineers, Reston, VA, *Published*.
3. Kirshen, Paul, Ray, Patrick, **Watkins, David W.**, 2011, "Incorporating Climate Change into Long-Range Water Supply Planning Using Scenario Analysis and Stochastic Programming", American Water Resources Association, *Published*.
4. Moore, Paul A., Couibaly, Paul, **Pypker, Thomas G.**, Waddintion, James M., 2010, "Can machines learn to fill eddy flux data better than standard methods?", Joint CMOS-CGU Congress, *Published*.
5. Ray, Patrick, **Watkins, David W.**, Kirshen, Paul, 2010, "Robust Optimization Using a Variety of Performance Indices", ASCE World Environmental and Water Resources Congress, American Society of Civil Engineers, Reston, VA, *Published*.
6. Welsh, S, Corace III, G, **Pypker, Thomas G.**, 2010, "Hydrological and ecological assessment of the Impacts of the Walsh ditch drainage plugs, Seney National Wildlife Refuge", editors: Pypker, T., 71st Midwest Fish and Wildlife Conference, *Published*.

### 6.2 Presentations

1. **Auer, Nancy A.**, Baker, Edward A., 2010, Population dynamics of lake sturgeon from over 20 years of mark and recapture in the Sturgeon River, Michigan., World Sturgeon Conference, North American Chapter -, Chico Hot Springs, MT, August 31, 2010 - September 2, 2010.
2. Hubsy, Elizabeth, Groves, Stephanie, **Bagley, Susan T.**, 2011, Adaptation of Escherichia coli KO11 form dilute acid pretreated industrial effluent, 2011 Spring Michigan Branch of the American Society for Microbiology Meeting, Michigan Branch of ASM, Grand Rapids, MI, April 9, 2011.
3. Liu, Zhicong, Sengupta, Aparupa, Groves, Stephanie, **Bagley, Susan T.**, 2011, Characterization of microorganisms recovered from lignocellulosic industrial waste stream effluent., 2011 Spring Michigan Branch of the American Society for Microbiology Meeting, Michigan Branch of ASM, Grand Rapids, MI, April 9, 2011.
4. Roll, Alex, Groves, Stephanie, **Bagley, Susan T.**, 2011, The effect of organic acids produced from the dilute acid pretreatment of lignocellulose on biomass and ethanol production in Pichia stipitis CBS 6054, 2011 Spring Michigan Branch of the American Society for Microbiology Meeting, Michigan Branch of ASM, Grand Rapids, MI, April 9, 2011.
5. **Bagley, Susan T.**, Saha, Ratul, Donofrio, Robert, 2010, Development of a TaqMan MGB Assay for the detection and quantification of Pseudomonas lubricans from metalworking fluids., 109th General Meeting of the American Society for Microbiology, American Society for Microbiology, Philadelphia, May 19, 2010.

6. **Becker, Jennifer G.**, Gregoire, Kyle, , 2011, Development of a microbial fuel cell to generate electricity from lignocellulosic biomass, Biological Sciences Seminar, Department of Biological Sciences, Michigan Technological University.
7. **Becker, Jennifer G.**, Gregoire, Kyle, , 2010, Development of a microbial fuel cell to generate electricity from lignocellulosic biomass, BioGas Summit, Flint Center for Energy Excellence, Swedish Biogas International USA, Flint, MI.
8. **Becker, Jennifer G.**, 2010, Microbial Fuel Cells: Recent Innovations and Applications, Environmental Engineering Graduate Student Seminar Series, Dept. of Civil and Environmental Engineering, Michigan Technological University.
9. **Breffle, William S.**, Eiswerth, Mark, Mahaparta, Aparajita, 2010, Measuring Human Preferences for Restoring a Community's Lakes and Fishery, Pathways to Success: Increasing Human Capacity for Global Human-Wildlife Coexistence, Colorado State University, Estes Park, CO, October 2010.
10. **Breffle, William S.**, Chestnut, Lauraine, Rowe, Robert, 2010, Economic valuation of mortality risk reduction: stated preference estimates for the U.S. and Canada comparing payment vehicles and elicitation methods, 3rd biennial American Society of Health Economists meeting, Cornell University, Ithaca, NY.
11. **Hutzler, Neil J., Chadde, Joan F.**, 2011, Exploring Family Engineering with Parents and Children, International Technology and Engineering Educators Association Annual Meeting, International Technology and Engineering Educators Association, Minneapolis, MN, March 24, 2011 - March 26, 2011.
12. **Chadde, Joan.** Coordinated K-12 Teacher Professional Development Summer Institutes for Michigan Tech University:
  - (1) Forest Ecology & Resources Institute ~ June 28 - July 2, 2010
  - (2) Future Fuels From Forests Teacher Institute ~ July 12-16, 2010
  - (3) Global Change Teacher Institute ~ July 19-23, 2010
13. **Chadde, Joan.** Family Engineering for Elementary Children & Their Parents. Michigan Science Teachers Association Annual Conference, March 4-6, 2010, Lansing, MI.
14. **Chadde, Joan,** and Mike Reed. Bringing Environmental Education to Urban Teacher Initiative. MSTA Annual Conference – Feb. 25-26, 2011, Grand Rapids, MI
15. **Chadde, Joan.** Michigan Environmental Education Curriculum Support (MEECS) Water Quality Unit Teacher Workshop. Michigan Science Teachers Association Annual Conference, Feb. 25-26, 2011, Grand Rapids, MI.
16. Kane, Evan S., Mazzoleni, Lynn R., Kratz, Carley J., Hribljan, J A., Johnson, Constance J., **Pypker, Thomas G., Chimner, Rodney A.**, 2010, Dissolved Organic Carbon in Peat Porewater Increases with Warming: A Field Manipulation Experiment in a Northern Temperate Bog, American Geophysical Union Fall Meeting, American Geophysical Union, San Francisco, CA, December 15, 2010.
17. **Chimner, Rodney A.**, 2010, Northern White Cedar Swamps- Ecology, Restoration and Management, Considerations and Innovations for Managing Michigan's Lowland Forests, The Michigan Society of American Foresters and The Michigan Chapter of Association of Consulting Foresters, Grayling, MI, November 4, 2010 - November 5, 2010.
18. **Chimner, Rodney A.**, 2010, Wetland Ecology and Restoration Lab, 2nd Northwoods Conference., Boulder Junction, WI, September 29, 2010 - October 1, 2010.

19. **Chimner, Rodney A., Ballantyne, D**, 2010, The effects of long term water table manipulations on carbon fluxes at the Seney National Wildlife Refuge, Society of Wetland Scientists 2010 Annual Meeting, Salt Lake City, June 28, 2010 - June 30, 2010.
20. **Flaspohler, David J.**, Webster, Christopher R., Roth, Amber, 2010, Intensive management of native forests for bioenergy: Quantifying trade-offs between forest productivity and biodiversity, Biodiversity and climate change: Direct and indirect linkages in adaptation and mitigation. XXIII World Congress International Union of Forest Research Organizations (IUFRO), International Union of Forest Research Organizations (IUFRO), Seoul, South Korea, August 2010.
21. **Alonso Contes, Carla A., Rios-Sanchez, Miriam, Gierke, John S.**, 2010, Lineament Mapping for Groundwater Exploration Using, 2010 Fall Meeting, AGU, American Geophysical Union, San Francisco, CA, December 13, 2010 - December 17, 2010.
22. **Rios-Sanchez, Miriam, Gierke, John S.**, Munoz-Martinez, Teresa, 2010, Lineament Mapping for Hydrogeological Characterization of Volcanic Terrains Using Products Derived from DEMs, Radar, Landsat and Aster Imagery, 2010 Fall Meeting, AGU, American Geophysical Union, San Francisco, CA, December 13, 2010 - December 17, 2010.
23. **Benjakul, Rengroj, Gierke, John S.**, 2010, Modeling Dioxane Transport in a Heterogeneous Glacial Aquifer System (Washtenaw County, Michigan) Using Publicly Available Models and Data, 2010 Fall Meeting, AGU, American Geophysical Union, San Francisco, CA, December 13, 2010 - December 17, 2010.
24. **Kerfoot, W. Charles, Yousef, Foad, Green, Sarah A.**, Regis, Robert S., Sabol, Bruce, Shuchman, Robert A., Brooks, Colin, Sayers, Michael, 2011, LiDAR (Light Detection and Ranging) Studies Of Lake Superior Coastal Environments: Mining Legacy In Grand Traverse Bay, 2011 Gay, Michigan Stamp Sands Technical Workshop, Weston Solutions, Houghton, MI, March 10, 2011 - March 11, 2011.
25. Bergstrom, Paul L., **Green, Sarah A.**, 2010, Sensor materials toward long term distributed monitoring, CILER-CEGLHH Workshop: Development and application of biosensors for monitoring human and ecosystem health, US NOAA, Ann Arbor, MI.
26. **Halvorsen, Kathleen E., Robles Morua, Agustin, Mayer, Alex S., Ballard, Meredith**, Watson, Katelyn, Vivoni, Enrique, 2010, Can hydrologic models change water-related risk perceptions? Results of a participatory modeling workshop in the Sonora River Basin, Mexico, American Geophysical Union Fall Meeting, American Geophysical Union, San Francisco, California, December 13, 2010 - December 17, 2010.
27. **Huckins, Casey J.**, 2011, Coaster Brook Trout (*Salvelinus fontinalis*) of Lake Superior: A Tale of Past and Current Threats, Xi Sigma Pi, American Society of Foresters, Michigan Technological University.
28. **Van Grinsven, Matthew, Mayer, Alex S., Huckins, Casey J.**, 2010, Estimation of Vertical Groundwater Fluxes into a Streambed through Continuous Temperature Profile Monitoring and the Relationship of Groundwater Fluxes to Coaster Brook Trout Spawning Habitat, American Geophysical Union Fall Meeting, American Geophysical Union, San Francisco, California, December 13, 2010 - December 17, 2010.
29. Eggert, Sue, Kolka, Randy, Brandt, Nathan, Rutten, Luke, **Huckins, Casey J., Marcarelli, Amy M.**, 2010, The role of research in aquatic habitat protection and restoration on National Forests and protected areas in the Midwest, Midwest Fish and Wildlife Conference, Minneapolis, MN.

30. **Marcarelli, Amy M., Huckins, Casey J.**, Eggert, Sue, 2010, Multi-scale drivers of ecosystem production in the Salmon Trout River, Science in the Northwoods Conference, USGS, UWisc, WDNR, USFS, Boulder Junction, Wisconsin, September 29, 2010 - October 1, 2010.
31. Eggert, Sue, **Huckins, Casey J., Marcarelli, Amy M.**, Mercier, Phillip, 2010, Using functional methods to monitor habitat rehabilitation of the Salmon Trout River, Michigan, Eastern Region Stream and Lake Riparian Restoration using Large Wood Materials workshop, USFS, Eagle River, WI, August 16, 2010 - August 20, 2010.
32. **Hutzler, Neil J., Chadde, Joan F.**, 2011, Exploring Family Engineering with Parents and Children, International Technology and Engineering Educators Association Annual Meeting, International Technology and Engineering Educators Association, Minneapolis, MN, March 24, 2011 - March 26, 2011.
33. **Kerfoot, W. Charles, Yousef, Foad, Green, Sarah A.**, Regis, Robert S., Sabol, Bruce, Shuchman, Robert A., Brooks, Colin, Sayers, Michael, 2011, LiDAR (Light Detection and Ranging) Studies Of Lake Superior Coastal Environments: Mining Legacy In Grand Traverse Bay, 2011 Gay, Michigan Stamp Sands Technical Workshop, Weston Solutions, Houghton, MI, March 10, 2011 - March 11, 2011.
34. **Kerfoot, W. Charles**, 2011, Brief Site History- Photographic Tour, 2011 Gay, Michigan Stamp Sands Technical Workshop, Weston Solutions, Houghton, MI, March 9, 2011 - March 10, 2011.
35. **Ebel, Jonathan D., Marcarelli, Amy M.**, Kohler, Andre, 2011, Biofilm response to nutrient mitigation using salmon carcass analog in Central Idaho Streams, ESC/BRC Student Research Forum, Ecosystem Science Center/Biotechnology Research Center, Houghton, MI.
36. **Ebel, Jonathan D., Marcarelli, Amy M.**, Kohler, Andre, 2011, Biofilm response to nutrient mitigation using salmon carcass analog in Central Idaho Streams, World Water Day Poster Competition, Center for Water and Society, Houghton, MI.
37. Collins, Scott F., Baxter, Colden V., **Marcarelli, Amy M.**, Wipfli, Mark S., 2011, Effects of experimental salmon carcass and analog additions on resident trout growth rates, abundance, and production, Annual meeting, Idaho Chapter of the American Fisheries Society, Boise, ID.
38. Baxter, Colden V., Wipfli, Mark S., **Marcarelli, Amy M.**, Kavanaugh, Katy L., Servheen, Gregg, Collins, Scott F., Felicetti, Laura A., Florin, Scott T., Wheeler, Tadd, Noble-Stuen, Andrea, 2011, Mitigating for the loss of marine nutrients from salmon: ecological effects of salmon carcass and analog additions to headwater aquatic and terrestrial systems in Idaho, USA, Annual meeting, Idaho Chapter of the American Fisheries Society, Boise, ID.
39. Bell, Alex, Collins, Scott F., Baxter, Colden V., **Marcarelli, Amy M.**, Wipfli, Mark S., 2011, Resident trout consumption of salmon carcass and analog added to tributaries of the North Fork Boise River, Idaho, Annual meeting, Idaho Chapter of the American Fisheries Society, Boise, ID.
40. Eggert, Sue, Kolka, Randy, Brandt, Nathan, Rutten, Luke, **Huckins, Casey J., Marcarelli, Amy M.**, 2010, The role of research in aquatic habitat protection and restoration on National Forests and protected areas in the Midwest, Midwest Fish and Wildlife Conference, Minneapolis, MN.
41. **Marcarelli, Amy M., Huckins, Casey J.**, Eggert, Sue, 2010, Multi-scale drivers of ecosystem production in the Salmon Trout River, Science in the Northwoods Conference, USGS, UWisc, WDNR, USFS, Boulder Junction, Wisconsin, September 29, 2010 - October 1, 2010.
42. Eggert, Sue, **Huckins, Casey J., Marcarelli, Amy M.**, Mercier, Phillip, 2010, Using functional methods to monitor habitat rehabilitation of the Salmon Trout River, Michigan, Eastern Region Stream

and Lake Riparian Restoration using Large Wood Materials workshop, USFS, Eagle River, WI, August 16, 2010 - August 20, 2010.

43. Wipfli, Mark S., **Marcarelli, Amy M.**, Kavanaugh, Katy L., Servheen, Gregg, Collins, Scott F., Felicetti, Laura A., Florin, Scott T., Baxter, Colden V., Wheeler, Tadd, 2010, Mitigating for the loss of marine nutrients from salmon: ecological effects of salmon carcass and analog additions to headwater aquatic and terrestrial systems in Idaho, USA, Annual meeting, Ecological Society of America, Pittsburg, PA.
44. Mineau, Madeleine M., Baxter, Colden V., **Marcarelli, Amy M.**, Minshall, G W., 2010, Retentive or leaky: How do stream ecosystems respond to carbon and nitrogen subsidies from non-native Russian olive (*Elaeagnus angustifolia*)?, Annual meeting, American Society of Limnology and Oceanography and the North American Benthological Society, Santa Fe, NM.
45. **Marcarelli, Amy M.**, Baxter, Colden V., Murakami, Masashi, 2010, Quantity and quality: the role of terrestrial subsidies in food web pathways and ecosystem metabolism in Horonai Stream, Annual meeting, American Society of Limnology and Oceanography and the North American Benthological Society, Santa Fe, NM.
46. Collins, Scott F., Baxter, Colden V., **Marcarelli, Amy M.**, Wipfli, Mark S., 2010, Responses of riparian insects and spiders to experimental additions of salmon carcasses, Annual meeting, American Society of Limnology and Oceanography and the North American Benthological Society, Santa Fe, NM.
47. Bechtold, Heather A., Baxter, Colden V., **Marcarelli, Amy M.**, Inouye, Richard S., 2010, Are nutrient loading effects on stream nutrient processing driven by shifts in biofilm community dynamics?, Annual meeting, American Society of Limnology and Oceanography and the North American Benthological Society, Santa Fe, NM.
48. **Martin, Susan R.**, 2010, The Use of the Portage River Area by Native Americans, Chassell Heritage summer series, Chassell Heritage Center, Chassell Michigan.
49. **Robles Morua, Agustin**, Vivoni, Enrique, **Mayer, Alex S.**, 2011, Distributed streamflow predictions based on precipitation data from sparse ground networks and the North American Land Data Assimilation System in Northwest Mexico, American Meteorological Society Annual Meeting, American Meteorological Society, Seattle, Washington, January 23, 2011 - January 27, 2011.
50. **Watson, Katelyn, Mayer, Alex S.**, Reeves, Howard, 2010, Assessing the spatial variability of constraints on groundwater abstractions due to potential adverse resource impacts on surface water ecosystems - a GIS based approach, American Geophysical Union Fall Meeting, American Geophysical Union, San Francisco, California, December 13, 2010 - December 17, 2010.
51. **Halvorsen, Kathleen E., Robles Morua, Agustin, Mayer, Alex S., Ballard, Meredith, Watson, Katelyn**, Vivoni, Enrique, 2010, Can hydrologic models change water-related risk perceptions? Results of a participatory modeling workshop in the Sonora River Basin, Mexico, American Geophysical Union Fall Meeting, American Geophysical Union, San Francisco, California, December 13, 2010 - December 17, 2010.
52. **Van Grinsven, Matthew, Mayer, Alex S., Huckins, Casey J.**, 2010, Estimation of Vertical Groundwater Fluxes into a Streambed through Continuous Temperature Profile Monitoring and the Relationship of Groundwater Fluxes to Coaster Brook Trout Spawning Habitat, American Geophysical Union Fall Meeting, American Geophysical Union, San Francisco, California, December 13, 2010 - December 17, 2010.

53. **Robles Morua, Agustin**, Vivoni, Enrique, **Mayer, Alex S.**, 2010, Spatial Streamflow Forecasting in a Large River Basin in Northwestern Mexico using a Fully-distributed Hydrologic Model, American Geophysical Union Fall Meeting, American Geophysical Union, San Francisco, California, December 13, 2010 - December 17, 2010.
54. **Muralidharan, Daya**, Knapp, Keith, 2010, Sustainability Economics of Groundwater Usage and Management, Toward Sustainable Groundwater in Agriculture – An International Conference Linking Science and Policy, San Francisco, California, USA, June 15, 2010 - June 17, 2010.
55. Twery, Mark, Janowiak, Maria, Swanson, Chris, Brandt, L, Palik, Brian, Bradford, John, **Nagel, Linda M.**, Webster, Christopher R., Hille, A, Johnson, S, Parker, Linda, , 2010, Preparing forest managers for an uncertain climate, The Ecological Society of America, 95 th Annual Meeting, The Ecological Society of America, Pittsburg, PA.
56. Kane, Evan S., Mazzoleni, Lynn R., Kratz, Carley J., **Hribljan, J A.**, Johnson, Constance J., **Pypker, Thomas G.**, **Chimner, Rodney A.**, 2010, Dissolved Organic Carbon in Peat Porewater Increases with Warming: A Field Manipulation Experiment in a Northern Temperate Bog, American Geophysical Union Fall Meeting, American Geophysical Union, San Francisco, CA, December 15, 2010.
57. **Seagren, Eric A.**, Wheaton, Matthew Y., 2010, A field demonstration of a quantitative framework for defining the limits on in situ bioremediation, Ninth International In Situ and On-Site Bioremediation Symposium, Battelle, Baltimore, MD, May 7, 2010.
58. **Kerfoot, W. Charles**, **Yousef, Foad**, **Green, Sarah A.**, Regis, Robert S., Sabol, Bruce, Shuchman, Robert A., **Brooks, Colin**, Sayers, Michael, 2011, LiDAR (Light Detection and Ranging) Studies Of Lake Superior Coastal Environments: Mining Legacy In Grand Traverse Bay, 2011 Gay, Michigan Stamp Sands Technical Workshop, Weston Solutions, Houghton, MI, March 10, 2011 - March 11, 2011.
59. **Urban, Noel R.**, **McDonald, Cory P.**, **Mwangi, Jennifer W.**, 2010, CO<sub>2</sub>, carbon cycling and acidification in Lake Superior, Ecology of Lake Superior: Integrated approaches and challenges in the 21st century, Aquatic Ecosys. Health Monitoring Soc. and U.S. EPA, Duluth, MN, May 3, 2010 - May 5, 2010.

### **6.3 Editorial Activities**

#### **Bagley, Susan T.**

Associate Editor, SIM News, Society for Industrial Microbiology, Appointed. January 1, 2008 - December 31, 2013.

Editorial Board Member, Journal of Industrial Microbiology and Biotechnology, Society for Industrial Microbiology, Appointed. July 1, 2003 - June 30, 2013.

Editor, Visual Resource Collection, MicrobeLibrary, ASM, Papers, Appointed. July 1, 2006 - June 30, 2012.

#### **Barkdoll, Brian D.**

Associate Editor, Journal of Hydraulic Engineering, ASCE.

#### **Campbell, Gary A.**

Associate Editor, Resources Policy, Papers, Appointed. January 2011 - Present.

Editorial Board Member, African Journal of Business Management. 2007 - Present.

#### **Doskey, Paul V.**

Editor, Journal of Great Lakes Research.

**Gierke, John S.**

Associate Editor, Journal of Contaminant Hydrology, Appointed. 2009 - Present.

**Halvorsen, Kathleen E.**

Editorial Board Member, Environmental Management, Editorial Board. 2006 - 2012.

Associate Editor, Society and Natural Resources, Associate Editor. 2006 - 2012.

**Martin, Patrick E.**

Editor, IA, The Journal of the Society for Industrial Archeology, Society for Industrial Archeology,

Appointed. January 1995 - Present.

**Rose, William I.**

Editor, Journal Editor, Journal of Volcanology and Geothermal Research.

**Scarlett, Timothy J.**

Editor, Guides to American Artifacts Series, Left Coast Press.

Editor, Book, The Material Culture of Breweries, Left Coast Press. January 2006 - March 2011.

**Seely, Bruce E.**

Editor, Comparative Technology Transfer and Society, Appointed. 2009 - 2010.

**Waddell, Craig**

Editorial Board Member, Environmental Communication Yearbook, Papers, Appointed. January 2002 - Present.

**Watkins, David W.**

Editorial Board Member, Journal of Water Resources Planning & Mgmt. (ASCE), Papers, Appointed. December 2004 - Present.

Associate Editor, Journal of Water Resources Planning and Management, Appointed. December 2004 - Present.

Associate Editor, ASCE Journal of Water Resources Planning and Management. 2004 - Present.

## 7 Appendix 1: CWS Faculty/Staff Participants

### **Biological Sciences**

Nancy A. Auer  
Susan T. Bagley  
Casey J. Huckins  
Charles W. Kerfoot  
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Emily Ninmann  
Stephanie Ogren  
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### Civil & Environmental Engineering

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Marcel Dijkstra  
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Jennifer Heglund  
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